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NIF Maintenance Plan March 2011

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National Ignition Facility

Maintenance Plan

March 2011

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National Ignition Facility Maintenance Plan

APPROVALS AND STAKEHOLDERS

The following roles are affected by this procedure. The current incumbents have been notified of the document changes.

Stakeholders

N/A

This procedure has been signed electronically in ECMS by the following people.

Action	Name	Title
Prepared by	Bernie Merritt	Maintenance Programs Manager
Reviewed by	Bernie Merritt	Facility Operations and Maintenance Manager
Reviewed by	Terry Land	NIF Site Manager
Approved by	Bruno Van Wonterghem	NIF Operations Manager

TABLE OF CONTENTS

1 INTRODUCTION

Ensuring the reliability of the NIF, including its support systems and utilities, is essential to ensuring the availability of the NIF in its support of laser operations.

This document identifies the policies and procedures necessary to perform and support the maintenance of the NIF's systems. These systems are all encompassing and include the facility, beampath, Line Replaceable Units (LRUs), Safety Interlock System (SIS), and diagnostics and utilities that create the environments within the beampath consisting of vacuum, argon, or clean dry air.

Policies governing administrative and operational practices related to maintenance are described in this plan. Processes and procedures for managing, tracking, and documenting the work are referenced in this plan. This document, the *NIF Operations Management Plan*,[1] and *NIF Shot Operations Plan*[2] together satisfy the requirements of the Conduct of Operations.

System level maintenance plans and procedures are also incorporated into this plan by reference.

Duties, responsibilities, and reporting requirements of the various positions associated with maintenance operations are detailed in this document.

Definitions of terms used in this document can be found in Appendix A. A list of acronyms used in this document can be found in Appendix B.

2 MAINTENANCE POLICY

2.1 Maintenance Organization Policy

A Maintenance Policy is essential to establish and ensure the continued development of high-performance maintenance programs. This document is NIF's maintenance policy which serves as guidance for efforts in achieving the maintenance goals.

NIF's Maintenance Policy is composed of a hierarchy of documents, where the top level provides general policy for maintenance in the form of process maps and work implementation procedures, and the lower tiers provide more specific guidance in the form of maintenance procedures and checklists (see Figure 1).

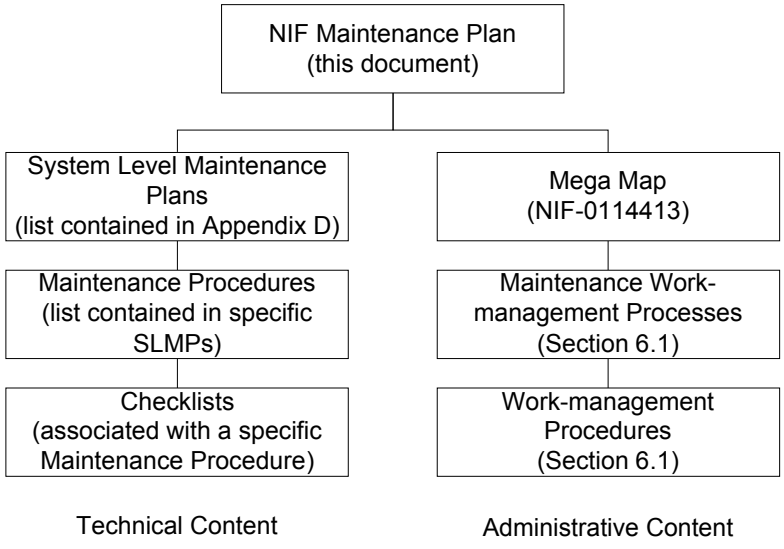


Figure 1. Maintenance Policy Hierarchy

The following sections provide descriptions for each tier of the Maintenance Policy.

- **Mega Map**—Represents the maintenance workflow and basic function of support activities (see Figure 2). Furthermore, it shows the interrelationship of various processes and sub-processes in order to provide an organization-wide overview for the purpose of creating commonality in performing maintenance.

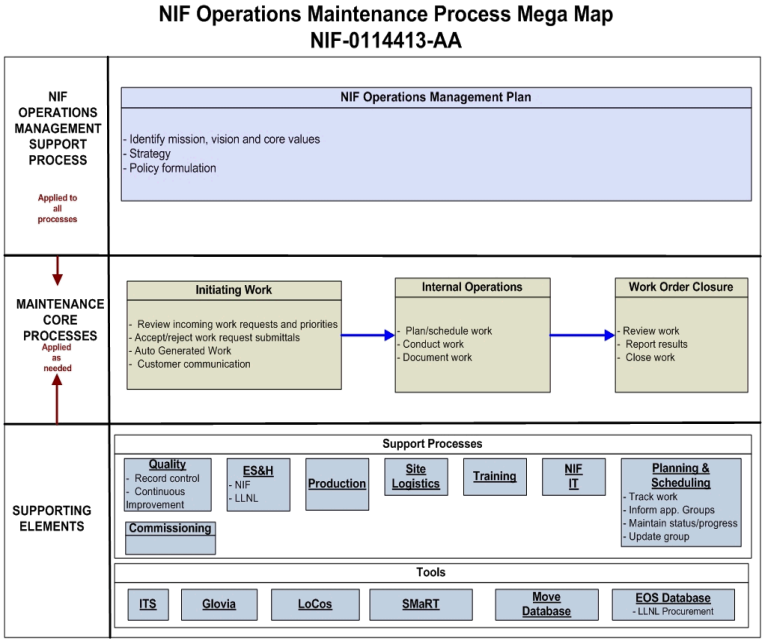


Figure 2. NIF Operations Maintenance Mega Map

- **Processes**—Graphical depiction of how work is performed from a defined initial point to a defined completion point (see Figure 3). A process also defines the associated procedures, related processes, subprocesses, and organizational responsibilities for each phase or step. A complete listing of the maintenance processes is in Section 6.2.

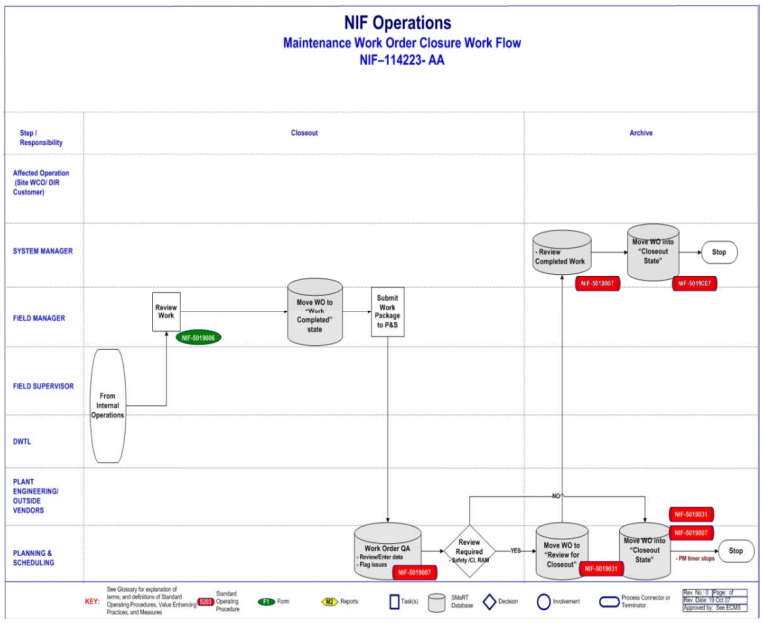


Figure 3. Example of Process Format

- **Maintenance Work-management Procedures**—A process may contain many Work-management Procedures. Because Processes are complex, encompassing, and may require further definition, Work-management Procedures provide the guidance for a specific portion of the process. Procedures further define responsibilities for each task and clarify the function of the organization. A complete list of Work-management Procedures organized by process is located in Section 6.2.

- **System Level Maintenance Plans—**System Level Maintenance Plans (SLMPs) describe the NIF's maintenance program applicability and implementation as it applies to a subsystem. Refer to Section 6.3 for additional information pertaining to SLMPs. There are over 200 subsystems within NIF and development of these SLMPs continues. NIF expects that, when completed, each subsystem will be documented with a SLMP developed as part of the MQ process. A template for the SLMP can be found on the NIF Procedure Templates webpage (https://nif-int.llnl.gov/procedures_docs_forms/ procedure_templates _tools.php).

- **Maintenance Procedures—**A maintenance procedure guides an employee through the performance of a specific work task. A maintenance procedure is generally more detailed, with a focus on how to perform one or more specific activities. Maintenance Procedures are generated as a result of the development of the System Level Maintenance Plans. A Maintenance Procedure template can be found on the NIF Procedure Templates webpage (https://nif-int.llnl.gov/procedures_docs_forms/procedure_templates _tools.php).

- **Checklists—**Checklists are working templates that aid workers in performing the task outlined in a maintenance procedure. A Checklist template can be found on the NIF Procedure Templates webpage (https://nif-int.llnl.gov/procedures_docs_forms/ procedure_templates _tools.php).

2.2 Maintenance Strategies

NIF chose the following strategies to guide the development, implementation, and execution of the Maintenance Policy.

- Appropriate levels of planning and scheduling are applied to jobs so that work is accomplished safely, productively, and on time, with required materials available.
- A computerized maintenance management system, established at NIF as the Systems Maintenance and Reliability Tracking tool (SMaRT), supports general administrative functions such as work processing, tracking, trending, scheduling, documentation archiving and retrieval, and equipment histories.
- Maintenance work is planned, tracked, and documented using a SMaRT work order.
- Work is authorized through a Location Component and State (LoCoS) work permit.
- Work is managed according to a priority system to apply the proper level of resources to the requirement.
- Metrics are used to measure the performance, and through analysis, serve to improve the maintenance program.
- Work is performed using established processes and procedures. Maintenance procedures and other work-related documents (which may include drawings and instructions) must be prepared and used to provide appropriate work direction and to ensure that maintenance is performed safely and efficiently.
- Work performed on configuration items shall adhere to the NIF Configuration Management procedures.
- NIF applies Reliability-Centered Maintenance (RCM) and Experience-Centered Maintenance (ECM) principles in developing maintenance plans.

2.3 Implementation Status and Future Plans

NIF Operations is expanding the maintenance program to all subsystems at NIF. This effectively results in the goal of including all equipment managed by the Commissioning, Operations, and Maintenance (COM) groups under this plan. In order to implement this goal, the maintenance program, and accordingly this document, needed to expand. Therefore, this document continues to be revised to work toward meeting the goals of the NIF Operations organization with regards to maintenance.

Accordingly, development continues or will be performed in several other major areas as follows:

First, each COM group has been tasked with developing hierarchies to include subsystems and equipment and subsequently develop and relate procedures and checklists to the hierarchy. This process is generally being phased for most COMs as follows:

- Facility Operations and Maintenance (FOM)
    - CF/BUS Utilities—current through April 2010
    - Beam Transport System—current through July 2010
- Laser COM—current through April 2010
- Target Area Ops and Integration COM—January 2010 through December 2010

Second, the implementation of the Maintenance Program goes beyond developing the basic information. Certain activities must be implemented in an approach that supports the implementation for each COM organization as described above. In order to ensure a coordinated approach to developing the program, a detailed maintenance implementation schedule is maintained. Denoted as the *Maintenance Implementation Plan*,[3] this schedule is a Microsoft Project 2007 document that resides in the Enterprise Configuration Management System (ECMS). The Maintenance Manager updates this schedule in response to program modifications and as work progress information becomes available.

Third, and to enable the functionality of the maintenance program, the capability of the various enterprise management tools (LoCoS, SMaRT, Glovia, ECMS) are being assessed, and requirements have been defined for potential future integration of the tools.

2.4 Maintenance Goals and Objectives

The goals are targets that are to be achieved by executing the maintenance program. These goals are measurable and defined as follows:

- Reliable, Available, and Maintainable (RAM) facility and support systems—Reactive Maintenance (RM) and Preventive Maintenance (PM) should be balanced to provide a high degree of confidence that equipment degradation is identified and corrected, that equipment life is optimized, and that the maintenance program is cost effective.
    - 0 RAM failures as reported in monthly RAM metrics.
    - 100% Availability of all systems excluding scheduled maintenance activities.
    - Preventive Maintenance/Reactive Maintenance ratio is > 4:1.
    - System, repair, and operational downtime are tracked.

- Maximize production/availability of systems at the highest efficiency, quality, and safety standards.
- Accurate equipment maintenance and operations records are maintained.
    - 100% of Work Orders are closed-out and documented in SMaRT.
    - 80% utilization of available technician work hours are tracked using the SMaRT system (Conventional Facility/Beampath Utility System [CF/BUS] Only).
    - Zero non-conformances identified during audits of inspection and maintenance records.
    - Less than one finding per audit hour identified during quarterly internal audits on process and maintenance records.
- All work is scheduled, planned, and performed on time.
    - Plan of the day (POD) identifies all work efforts.
    - All work should be performed with a Work Order.
    - Work Order Aging is less than:
        - 30 working days for Priority 1 and 2 Work Orders.
        - 60 working days for Priority 3 Work Orders.
- Work is performed safely in accordance with the NIF Safety Program.
- Maintenance Implementation:
    - Maintenance Procedures are produced according to the MQ implementation schedule.
    - Metrics are used and a baseline is established for continuous improvement.
- Reduce the number of unplanned outages.
- Reduce the impact of planned outages by planning and completing maintenance activities promptly.
- Manage the corrective maintenance backlog to minimize it and the completion time of resolving outstanding deficiencies.
- Complete scheduled surveillance and PM activities promptly.
    - Work complies with the documented PM Schedule in the SLMP.
- Staff and train the maintenance organization.
    - Work complies with the documented PM Schedule.
- Complete work on schedule (includes outage work).

3 SCOPE OF MAINTENANCE PROGRAM

3.1 Physical Locations and Areas Under the Maintenance Program

This document governs maintenance on the NIF, including the Laser and Target Area Building (B581), Optics Assembly Building (B681), and associated utility pads and outbuildings (B582, B682, B683, B684).

3.2 Subsystems Under the Maintenance Program

NIF contains over 160 subsystems and the maintenance approach is tailored for each subsystem. The NIF maintenance program's applicability and implementation as it is applied to an individual subsystem is documented in the associated System Level Maintenance Plan (SLMP).

The SLMP may be found in ECMS by looking up the subsystem name in Appendix D (which is a representation of the Unified System Hierarchy) and then locating the associated ECMS number for the SLMP. Then using ECMS, search for the latest version of the SLMP.

4 TYPES OF MAINTENANCE

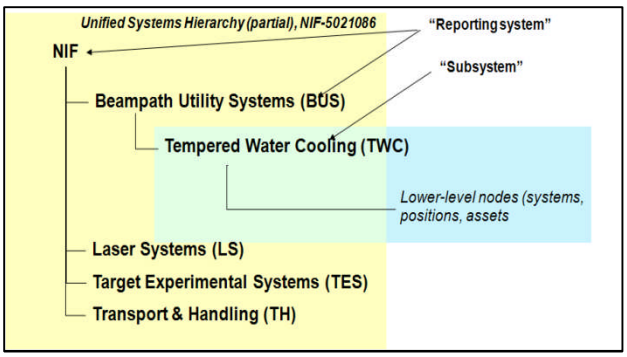
4.1 Master Equipment List

A Master Equipment List (MEL), a detailed list of safety and non-safety equipment, components, and structures, identifies the equipment in the maintenance program. The MEL also includes special tools and equipment.

NIF's subsystems, equipment, and assets then are further categorized into a structured list or Technical Hierarchy. Multiple hierarchies are used to organize and structure NIF's equipment. However, all hierarchies report to one overriding hierarchy, that is the Unified System Hierarchy.[4] The Technical Hierarchies are further discussed in Section 8.4.1. For further information on the Unified System Hierarchy, refer to the *NIF Operations Management Plan*.[1]

The Unified System Hierarchy organizes the subsystems into a singular structure for reporting. The common node representing all equipment at NIF and also the highest node of the USH resides in "The NIF". Beneath NIF are the reporting nodes or Reporting Systems. These are so named because NIF intends to run summary reports at this level or below. Furthermore, Reporting Systems only contain Subsystems or other Reporting Systems. Beneath the Reporting Systems are the Subsystems.

Subsystems are an important part of how NIF views the SSCs and are an important element for organizing information, attributes, and data. Subsystems are the lowest point on the USH and at the same time are the highest node for those subsystems contained in SMaRT. Each subsystem contains lower-tier subsystems, positions, and assets in successively more detailed levels. Within the USH, the subsystem is assigned a specific designator (critical for database management), Subsystem Manager, Energy Owner, CCB5, and COM.



Reporting Systems
- SMaRT is designed to generate reports at these nodes
- Only subsystems are attached to these nodes

Subsystems
- Primary grouping of equipment
- point for assigning Subsystem Managers, COMs, Energy Owners, and CCB5s

Figure 4. System Relationships

The relationships between the various aforementioned systems are shown in the figure. Contained within the subsystems are more detailed systems, positions, assets, locations. The equipment contained in the subsystem is listed in one or more databases according to the maintenance approach outlined in the SLMP. For many subsystems, the remainder of the MEL will reside in SMaRT. For those subsystems with significant assets in LoCoS/Glovia, the approach is to continue to list those assets in Glovia with the user interface and reporting being performed through LoCoS.

4.2 Preventive Maintenance

Preventive Maintenance consists of all those systematically planned and scheduled actions performed to prevent equipment failure. The PM program defines the required activities and the frequency with which they should be performed. Selection of required PM actions are based on manufacturers' recommendations, industry and NIF experience, and good engineering practice. PM frequency is based on adequately implementing the entire program, considering such elements as predictive maintenance results, vendor recommendations, and monitoring of performance. The SLMP provides the basis for the planned actions through a combination of RCM and ECM analysis.

4.2.1 The Preventive Maintenance Process

NIF's PM program is continually updated via an evolutionary process. It began with the scheduling of routine tasks done based on such items as regulatory requirements, codes and standards, vendor recommendations, facility and industry experience with similar equipment, engineering analysis of equipment performance, systematic analysis through predictive maintenance, history records of equipment performance, cost/benefit analysis, capacity need, and schedule use. It will be revised as additional history and trends indicate.

4.2.2 Interval of Preventive Maintenance Tasks

The initial interval for PM tasks is established to maximize equipment reliability. The objective of NIF's maintenance program is to increase the availability of equipment by eliminating hidden faults before equipment is disabled. Because an effective PM program should reduce the overall failure rate of the equipment involved while minimizing the downtime of the equipment and the possibility of introducing new failures, the best method to determine PM frequency is to make it an optimization problem. This means on the one hand, that the availability increases because of a decrease in failure rate (by eliminating hidden faults), and on the other hand, that availability decreases because of an increase in downtime. Therefore, there is an interval (or frequency of maintenance) that yields the maximum achievable availability. Risk-significant equipment for which an increase in availability can most reduce facility risk should be selected for an optimized PM.

Optimization of maintenance intervals involves the following general activities:

- Reporting PM activities, plans, and schedules;
- Calculating the PM interval by balancing availability, reliability, and cost;
- Ranking PM tasks;
- Accessing PM information from piping and instrumentation drawings (P&IDs);
- Accessing PM and other maintenance data;
- Listing recurring failure modes/parts including failure to start and failure to run;
- Calculating and monitoring SSC availability;
- Accessing PM procedures; and

- Keeping track of PM cost.

4.2.3 Scheduling and Tracking Preventive Maintenance Performance

1. A PM schedule is developed by applying the periodicity (Section 4.2.2).
2. PM work packages are prepared for each task.
3. PM tasks are capable of being quickly sorted and listed by system and system operational condition (future) required to perform the task.

   Note: This aids in planning work items, especially when being performed during forced outages and changes in operating conditions, and also aid in scheduling PM tasks by system/subsystem to increase overall equipment capacity.
4. PM should be scheduled at appropriate intervals and, where practical, with corrective maintenance and surveillance, and other related maintenance on the same equipment.
5. Grace periods are specified in the PM program. Refer to Section 4.7 for further discussion pertaining to overdue maintenance.
6. Delays in the performance of scheduled PM tasks beyond the defined grace period require escalating approval. Refer to Section 4.7.
7. For example, approval should be obtained from supervisors, operations managers, maintenance and engineering managers, and the NIF Operations Manager, depending on the length of time that the task is to be delayed and the potential risk involved.
8. Field Managers and Supervisors are encouraged to recommend changes in PM task interval based on real-time observations and conditions. These changes are incorporated into the SLMP and routed for approval before the change becomes effective.
9. The maintenance manager should report monthly to the FOM any associated problems with scheduled PM tasks, including the number exceeding the grace period.

4.2.4 Performance of Preventive Maintenance Tasks

PM tasks are performed using procedures or instructions and controlled by methods such as Qualification cards and coordinated with NIF Operations through Work Permits.

Good work practices (such as a SPA, pre-job meetings, quality craftsmanship, work observations, data recording, cleanliness, correct tool use, and history update), and good leadership practices to sustain good work practices, are essential to the PM task.

4.3 Component Failure Trending

A PM program is designed to maintain the reliability of equipment. This reliability may be determined by analyzing the failure or performance history of the equipment or component. Therefore, failures should be trended to produce a record of component performance and provide indicators to facilitate changes in the component's design or the applicable PM tasks. The trending program should include selected critical components so that the most effective adjustments to the PM program may be made. Suggested data includes failure times/dates, failure modes/causes, and statistically derived data such as failure rates. These parameters may be determined from facility-specific or industry data.

Adverse trends in failure data should initiate an evaluation or investigation to determine and correct the causes of the problems. The following method may be used to determine whether the results of component failure trend analysis warrant changes to the PM program.

1. If a PM task exists but the trend analysis shows an increase in failures, a review of the component analysis may be necessary to determine whether an additional failure mode should be considered or the adverse trend is caused by programmatic deficiencies. Additionally, consideration should be given to decreasing the existing PM task interval.
2. If a PM task exists and there are no failures over a significant period of time, then consideration should be given to increasing the task interval. In this case, it may be advantageous to use a condition monitoring task to determine the optimum task frequency and to determine whether the task is applicable and may effectively detect degradation before a failure occurs.

Timely collection and analysis of failure data is essential to improving component performance. Incomplete failure and repair descriptions on WRs/WOs often hinder timely analysis. One method that has proved to be effective in obtaining trending information on job requests is to initiate use of failure and repair codes.

Other sources of data that should be used to make adjustments to the PM program are performance-monitoring and predictive-monitoring programs. Results of these programs may provide indications of adverse trends and may help identify components with performance or reliability problems.

To be effective in maintaining facility equipment design conditions with high levels of availability, the PM program should contain appropriate tasks, be properly executed, and be routinely reviewed and updated.

4.4 Predictive Maintenance

Predictive Maintenance should be integrated into the overall PM program so that planned maintenance may be performed before equipment failure. Not all equipment conditions and failure modes can be monitored; therefore, predictive maintenance should be selectively applied. Reliable predictive maintenance is preferable to periodic internal inspection or equipment overhauls.

Predictive maintenance should be limited to components and systems that are significantly important to the safe and reliable operation of the facility. The program should collect, trend, and analyze data and initiate planned actions for degrading equipment. The effectiveness of the program is highly dependent on accurately predicting the equipment degradation rate and the time to assess the imminent failure.

4.5 Selection of Maintenance Techniques

The criticality of any system greatly impacts the decision-making as to the choice of maintenance strategies and the level of allocated resources. Critical systems, as identified by lower criticality numbers, are more “Mission Critical” in terms of laser shot success to the NIF Organization than those systems with higher criticality numbers. As a result, a more proactive approach from maintenance is taken for certain systems with lower criticality numbers through the application of specific proactive maintenance strategies (i.e., Predictive). Conversely, a more reactive maintenance strategy (i.e., Run-to-Failure) and a reduced level of allocated resources is taken for those systems that are deemed less critical to shot success, as indicated by higher system criticality numbers.

The criticality values listed in Table 1 are derived using a formula that considers if the system contains a Configuration Item (CI), the time it takes to repair major components of the system (RT), and the operational impact (OI) of a typical failure. These terms are then multiplied together to yield an overall criticality rating. These three terms are described in more detail in Appendix C.

Table 1. Criticality Values

Subsystem Name	Operational Impact (OI)	Repair Time (RT)	CI (Yes / No)	C (OI × RT × CI = C)
Safety Interlock System (SIS)	1	1	1	1
Electrical Utility (EUS)	1	1	1	1
Chilled Water (CHW)	1	1	2	2
HVAC and EPS (HVAC)	1	2	1	2
Tower Water (TW)	1	1	2	2
Argon (ARG)	1	2	1	2
Diagnostic Vacuum (DIAV)	1	2	1	2
FOA Vacuum (FOAV)	1	2	1	2
Target Chamber Vacuum (TCV)	1	2	1	2
Liquid Nitrogen (N_2)	1	3	1	3
Emergency Voice/Paging/Security Alarm (EVAC)	2	2	1	4
Fire Alarm (FAS)	2	2	1	4
Fire Protection Water (FPW)	2	2	1	4
Lifting, Handling, and Conveyance (LH)	2	1	2	4
Amplifier Cooling (AMP)	1	2	2	4
Clean Dry Air (CDA)	1	2	2	4
FOA Cooling (FOAC)	1	2	2	4
Backfill Air (HA)	1	2	2	4
PEPC Vacuum (PEV)	1	2	2	4
SF Vacuum (SFV)	1	2	2	4
Tempered Water Cooling (TWC)	1	2	2	4
Optics Assembly Building (OAB)	1	2	2	4
Pre Amplifier Beam Transport (PABVAC)	1	2	2	4
Safety Equipment (SAFE)	2	2	1	4
Hot Water (HW)	3	1	2	6

Subsystem Name	Operational Impact (OI)	Repair Time (RT)	CI (Yes / No)	C (OI × RT × CI = C)
Compressed Air (CA)	1	3	2	6
CargoVator Conveyance (CV)	3	1	2	6
Exhaust Air (EA)	1	3	2	6
PDS Vacuum (PDSV)	1	3	2	6
Process Gas (PG)	1	3	2	6
Target Chamber Service System (TCSS)	3	1	2	6
Measurement and Test Equipment (MTE)	2	3	1	6
Direct Digital Controls (DDC)	2	2	2	8
Low Conductivity Water (LCW)	2	2	2	8
Building Structures (BLD)	3	3	1	9
OAB De-ionized Water (includes Reverse Osmosis) (DI)	3	2	2	12
Demineralized Water (DW)	3	2	2	12
Process Water (PW)	3	2	2	12
Sewer & Retention (SS)	3	2	2	12
Storm Water (SW)	3	2	2	12
City Water (CW)	3	3	2	18
Facility Lighting (LTG)	3	3	2	18

As the maintenance program matures, systems should be periodically evaluated against operating requirements as defined in Requirements Maintenance System (RMS). In determining modifications to the maintenance programs or procedures, Table 1 should be referenced to ensure that more critical systems receive the appropriate level of maintenance as shown in Table 2.

Table 2. Criticality Maintenance Evaluation

Criticality (refer to Table 2)	Primary maintenance approach	Maintenance strategy
1-4	Condition-based and time-based	Predictive, preventive and reactive maintenance
6-10	Time-based	Preventive and reactive maintenance

Criticality (refer to Table 2)	Primary maintenance approach	Maintenance strategy
Over 10	Time-based or run-to-failure (selected strategy is determined by the Subsystem Manager for each equipment asset)	Preventive and reactive maintenance or run-to-failure

4.6 Deferred Maintenance

Deferred Maintenance is known maintenance work in which a conscious decision is made to not perform it. The decision not to perform this maintenance work can be based upon end of asset life cycle, planned shutdown that would minimize operational impacts, planned project work, etc. Deferred maintenance does add to the backlog of maintenance and repairs, but is not included in NIF's backlog calculations. Refer to Section 8.4.4 for information on its handling in SMaRT.

In order to effectively address a deferred maintenance backlog, NIF must:

1. Identify why projects, maintenance, and repairs have been deferred.
2. Recognize and understand the scale of the problem.
3. Quantify and communicate the financial impact of deferred maintenance.
4. Prioritize projects and develop a strategy to secure adequate funding.
5. Conduct preventive maintenance and complete repairs promptly to avoid backlog redevelopment.

4.7 Overdue Maintenance

A grace period of 25% of the periodicity of planned maintenance exists. Overdue Maintenance is known maintenance work that has not been performed by its due date. Delays in the performance of scheduled PM tasks beyond the defined grace period require the approval of the CSM and NIF Operations Manager. Overdue maintenance beyond the grace period adds to the backlog of maintenance and repairs and is included in NIF's backlog calculations. Refer to Section 8.4.4 for information on its handling in SMART.

5 MAINTENANCE ORGANIZATION AND ADMINISTRATION

5.1 Staffing Resources

This section defines the maintenance organization's roles and responsibilities. For those responsibilities that are defined elsewhere, a reference to that document is noted.

5.1.1 Facility Operations and Maintenance Manager (FOM Manager)

The duties of the FOM Manager are described in the *NIF Operations Management Plan*.[1]

5.1.2 Maintenance Programs Manager (MPM)

The duties of the MPM are described in the *NIF Operations Management Plan*.[1]

5.1.3 Conventional Facility/Beampath Utility Systems (CF/BUS) System Commissioning, Operations, and Maintenance Manager (CF/BUS COM)

The duties of the CF/BUS COM are described in the *NIF Operations Management Plan*.[1] Additionally, periodically review the Required Reading Binder (refer to Section 10).

5.1.4 Subsystems Managers

The roles and responsibilities of the Subsystems Managers are described in the *NIF Operations Management Plan*.[1] In addition, the SSMs are expected to support 24/7 operations.

5.1.5 Planning and Scheduling

The Planning and Scheduling function supports the Work Order process for The NIF Site. The Planning and Scheduling Group consists of Planners and Schedulers whose job functions are described in Appendix M. The Planning and Scheduling group performs the following functions:

- Creates work packages and work plans.
- Staffs the Request Line (4-FCOM), including receiving customer requests and generating reactive Work Orders.
- Processes Work Orders.
- Coordinates and plans utility outages.
- Monitors the life cycle of Work Orders from generation to closure.
- Generates key performance indicator (KPI) data in support of FOM and NIF Operations.
- Performs Work Order closeout and record archiving.
- Acts as the SMaRT Administrator responsible for database configuration management, user training, and development of business rules.
- Primary interface to the SMaRT Information Technology (IT) Product Manager for SMaRT development and maintenance.

5.1.6 Conventional Facilities, Operations, and Maintenance (O&M)

The CF O&M Group operates and maintains the Conventional Facilities and utility systems. The CF O&M Group is led by the CF Field Manager. Work is directed in the field by Field Supervisors and performed by Technicians. Work for this group is relayed via a Work Order. To perform work in the field, work must be approved through the NIF Work Permit process. Specific responsibilities of this group include:

- Operate and maintain the NIF's conventional facilities and utilities including general site maintenance, including road/parking lots, and hardscaped areas.
- Manage excess wood, scrap metal, trash pickup, and disposal.
- Support construction activities including:
    - Manage/maintain/repair construction equipment.
    - Support Energy Ownership.
    - Obtain soil and concrete penetration permits.
    - Obtain Hot Work Permits.

- Support planning and execution of utility outages.
- Maintain and repair personnel and material lifts.
- Manage/maintain rental lifts.
- Soil and concrete penetration permits.
- Perform corrective and preventive maintenance as specified through Work Orders documented in SMaRT.
- Ensure operations are performed in accordance with safety standards, requirements, processes, and procedures.
- Monitor indicators of performance through metrics.

5.1.7 Beampath and Process Utilities Operations and Maintenance (O&M)

The BUS O&M Group operates and maintains the Beampath process utilities. The BUS O&M Group is led by the BUS Field Manager. Work is directed in the field by Field Supervisors and performed by Technicians. Work for this group is relayed via a Work Order. To perform work in the field, work must be approved through the NIF Work Permit process. Specific responsibilities of this group include:

- Operate and maintain beampath and process utilities.
- Serve as interface for all O&M scheduling activities.
- Perform corrective and preventive maintenance.
- Ensure operations are performed in accordance with safety standards, requirements, processes, and procedures.
- Provide Industrial Control System (ICS) operators for Control Room operations.
- Perform on-the-job training of workers and document on Qualification Cards.
- Monitor indicators of performance through metrics.

5.1.8 General Requirements for Field Managers

The general requirements for Field Managers include:

- Maintain a binder for Required Reading (refer to Section 10).
- Coordinate day-to-day work with affected parties (e.g., equipment maintenance) by writing work plans and work permits.
- Act as the Work Permit Responsible Individual (WPRI).
- Assign work to Field Supervisors.
- Monitor work team safety to ensure that controls are properly implemented.
- Maintain training, follow all safety protocols, and adhere to posted signs and barricades.
- Participate in a Pre-shift Brief (Safe Plan of Action [SPA] Meeting). See Section 9 on Shift Turnover.

- Promptly inform the Subsystem Manager or NIF Operations personnel as required using the LoCoS Problem Log of out-of-specification parameters for equipment, changes in equipment status, or other equipment deficiencies.
- Promptly respond to equipment alarms.
- In the event of an emergency and without obtaining prior approval, take the necessary immediate actions required to ensure personnel, equipment, and environmental safety, to the extent that their safety and the safety of others is not jeopardized.
- Stop work if work conditions are found to be unsafe.

5.1.9 General Requirements for Field Supervisors

The general requirements for Field Supervisors include:

- Coordinate day-to-day work with affected parties (e.g., equipment maintenance) by writing work plans and work permits.
- Act as the Work Permit Responsible Individual (WPRI).
- Assign work to technicians and/or operators.
- Manage daily work teams and audit work documentation (may also perform work).
- Monitor work team safety to ensure that controls are properly implemented.
- Maintain training, follow all safety protocols, and adhere to posted signs and barricades.
- Participate in a Pre-shift Brief (Safe Plan of Action [SPA] Meeting). See Section 9 on Shift Turnover.
- In the event of an emergency and without obtaining prior approval, take the necessary immediate actions required to ensure personnel, equipment and environmental safety, to the extent that their safety and the safety of others is not jeopardized.
- Stop work if work conditions are found to be unsafe.
- Promptly inform the Subsystem Manager, Field Manager, or NIF Operations personnel as required using the LoCoS Problem Log for out-of-specification parameters for equipment, changes in equipment status, or other equipment deficiencies.
- Promptly respond to equipment alarms.

5.1.10 General Requirements for Maintenance Operators/Technicians

- Receives Work from Field Supervisors.
- Performs Equipment Maintenance/Repair/Misc tasks or Operates software according to set procedures.
- Documents work completion.
- May lead a daily work team (DWTL) and conducts the SPA.
- Ensures that Work Permit controls and implemented.
- Stops work when required/asks for support.
- Maintains training, follow all safety protocols and adhere to posted signs and barricades.

- Prior to assuming responsibilities and duties for a control console (and with SD approval), operators will conduct a thorough turnover per Section 9.
- Participates in a Pre-shift Brief (SPA Meeting). See Section 9 on Shift Turnover. Follows procedures and checklists. Informs the Subsystem Manager of necessary changes. Promptly informs the Field Manager of alarms, out-of-specification parameters for equipment, or other equipment deficiencies. If the Field Manager is not available, escalates the notification to the Work Control Office, Systems Manager, Facility Duty Officer, or if necessary, uses the NIF Incident Notification process.
- In the event of an emergency and without obtaining prior approval, takes the necessary immediate actions required to ensure personnel, equipment, and environmental safety, to the extent that their safety and the safety of others is not jeopardized.
- Stops Work if work conditions are found to be unsafe.
- Technicians check in with the Field Supervisor at the beginning of the shift and check out at the completion of the shift.
- Performs independent verification in support of maintenance tasks completed by others.
- Immediately reports equipment deficiencies to Field Supervisor or Field Manager.

5.2 O&M Support for 24/7 Operations

This element of the maintenance program assures system and utility reliability to the NIF Facility 24 hours a day, 7 days a week. For continual support, the following coverage has been coordinated.

- Regular Shift Coverage—Based on on-site staffing solutions for Field Supervisors, Technicians and ICS Operators.
- On-Call Coverage—Supplements the Regular Shift Coverage by providing on-call support during the hours in which maintenance technicians are not on site.
- NIF Ops Facility Duty Officer—Reinforces the On-Call Coverage. Refer to the *NIF Operations Management Plan*.[1]

5.2.1 Regular Shift Coverage

CF/ BUS O&M Groups support Shot Operations with a 7-day, 12-hour regular work schedule. This schedule is applicable to Field Supervisors and Technicians. Two teams of workers (Teams A and B) are selected to provide sufficient staffing for complete coverage for the week. Each team is led by a Field Supervisor. The CF and BUS O&M Groups focus on their specific work fronts and provide Field Supervisors from within their groups; however, the groups will work together for coordination of schedules and in the general performance of work. Weekly planning and technical coordination are performed on overlap days, i.e., Wednesdays.

Treatment of Holidays: The Field Managers established the minimum staffing levels for holiday work based on operational requirements.

5.2.2 On-Call Coverage

The NIF Ops On-Call program is used for the hours of operation for which no on-site support exists. The assignment of workers to "On-call" status is based on the operational needs of the facility. The on-call program is applicable to those workers who are designated Field Supervisors. Refer to NIF Procedure 11.2, *NIF Operations On-Call Field Supervisor Response*.[5]

5.2.3 NIF Ops Facility Duty Officer

For the NIF facility, the role of the Facility Duty Officer is assigned to several managers in the NIF Operations organization. However, only one manager performs this role at any time and generally for a 1-week period. The assignment is rotated among the assigned managers.

The NIF Operations Manager (NOM) selects and authorizes managers to perform the role of the NIF Ops Facility Duty Officer. The current roster of managers that are on rotation to perform this role is regularly published via email. Also, a copy of the roster is included in the NIF Facility Duty Officer journal.

The primary role of the Duty Officer is to address issues requiring managerial decisions in support of the NIF Operations. The procedure describing the functions and duties of the Facility Duty Officer is NIF-5018691.[6]

5.3 Tools

Tools are defined as devices used by a worker to enact work on a system, subsystem, or component such as a wrench, power tool, fixtures, or digital multi-meter. A tool may also be a device that supports activities allowing workers to conduct work in a safe manner and/or more efficiently such as a flashlight, radio, or ladder. Tools are broken down into two categories: General-Use Tools and Job-Specific Tools.

General-Use Tools are tools provided to each worker or work team that are used on a regular basis to complete tasks. General-Use Tools are maintained and managed by the worker or team to whom they are assigned. Worker- or team-assigned General-Use Tools should be inventoried daily by the worker to determine if any tools have been broken or lost. Lost tools will be reported to the Property Manager, and the worker or team shall order replacements. Broken tools will be reported to the Tool Crib, which will issue replacements or effect repairs. The Site Logistics department will inventory tools that have been checked out for use in the field, on a monthly basis. The Calibration Coordinator will ensure that M&TE tools in the Tool Crib are maintained within calibration.

Job-Specific Tools are tools that are of high monetary value or in short supply, which are used on an infrequent basis. Job-Specific Tools are maintained and managed through the Tool Crib and are checked out by the worker when needed. Job-Specific Tools are signed out for the duration of a job, not to exceed the return date and/or calibration due date.

Other Tools are fall protection (fall restraints, lanyards, etc), fire extinguishers, and general use personal protective equipment (PPE) (safety glasses, hard hats, gloves, etc.) and job consumables (rags, etc.). These tools shall be managed by the Site Logistics department, which will assume responsibility for their serviceability and perform visual inspection prior to issuance to workers. Upon issuance, it becomes the worker's responsibility to inspect the items prior to each use and maintain them in proper working order. It is also the worker's responsibility to report any known damage or problems with the tools at the time of return to the Tool Crib. It is the responsibility of the worker/DWTL to bring the tools to the Tool Crib for inspection when a recall notice is received.

5.4 Outside Service Providers

The Field Manager decides when an Outside Service Provider is desired to perform the maintenance on a system or a portion thereof.

Outside service providers are defined as:

- Internal to LLNL (e.g., Plant Engineering, Fire Department)—a Memorandum of Understanding is written to clarify scope of work and areas of responsibility.
- Outside vendor—a Service Contact is used to clarify the scope of work and responsibility.

5.4.1 Memorandum of Understanding (MOU)

MOUs are generated to implement a cooperation or agreement between NIF and another organization at LLNL. The MOU includes specific information regarding the requirements of the services or maintenance being requested. An MOU shall be on NIF letterhead and include a specific title, purpose, scope, definitions, responsibilities, date of acceptance, effective date, method of payment, review frequency, acceptance clause for changing conditions, and the Associate Director's or Senior Manager's approval signature(s) and date.

MOUs are reviewed for mutual acceptance and are readily available to personnel. All NIF MOUs associated with this maintenance plan are documented in ECMS.

The Table 3 lists the MOUs that are in place or planned with various LLNL Organizations to perform maintenance activities on identified NIF Systems.

Table 3. NIF MOUs

Subsystem	Provider	MOU Reference Document	NIF ECMS Number
FPW FAS EVAC	LLNL Emergency Management Department	Fire Alarm Systems MOA between the NIF Directorate and the Emergency Management Department	NIF-5020632

5.4.2 Service Contracts

Outside service vendors provide specific technical services in support of the NIF mission.

A service contract outlines the responsibilities and commitments of NIF and the Outside Service provider. Service contracts in place for the CF/BUS Systems are listed in the specific system level maintenance plan.

It is intended to document service contracts within SMaRT to better allow outside service contractor work to be tracked against specific equipment and to apply the planning and scheduling processes to this work.

5.5 Training and Qualification of Maintenance Personnel

NIF workers, specifically excluding contracted service providers who are new to an area, may have a thorough technical background and a theoretical understanding of an operation, but on-the-job training (OJT) may still be required to ensure they understand the specific details of an operation. Work conducted by personnel under instruction shall be carefully supervised to avoid errors that could have significant impact on safety or operations. OJT should be conducted so that the trainee satisfactorily completes all of the required training objectives and receives the maximum learning benefit from this experience.

NIF's approach for ensuring that workers are trained to perform the work includes:

- The applicable eIWS will state the minimum training required to perform a task, which the Work Permit Responsible Individual (WPRIs) will verify to have been completed when assigning workers to that task.
- A Maintenance Procedure may additionally state unique training requirements or skills necessary to perform that procedure.

5.5.1 Qualification

To automate the process by which appropriately qualified workers are assigned to a Work Order, the following is in process of phased implementation via the SMaRT System:

- Each employee will be grouped into a Trade based on his/her general job function (e.g., Advanced Maintenance Technician).
- Each employee may also have one or more Qualifications based on specialized job function (e.g., HVAC Technician).
- For Preventive Maintenance tasks, these Qualifications will be pre-applied in SMaRT's Preventive Maintenance Schedule.
- For Reactive Maintenance tasks, Qualifications may also be applied, on one of two bases:
    - The Work Order has been assigned to at least the Subsystem level (refer to the Unified System Hierarchy), and the Subsystem Manager has indicated in the SLMP that specific qualifications are required for maintenance of that Subsystem.
    - A Reactive Maintenance procedure exists which identifies that a specific qualification is required.
- Any specified Trade and Qualification will appear on the Work Order, so that this information is available during work planning.

5.6 Quantitative Indicators

NIF has established a program to regularly provide management with accurate information regarding key maintenance performance indicators. These Key Performance Indicators (KPI) are measurable and used to assess maintenance performance and identify areas requiring management attention. KPIs include overall indicators relevant to maintenance performance, indicators to measure progress in achieving goals and objectives, and specific indicators for monitoring current performance problems and performance in specific functional areas.

Key Performance Indicators listed in this Maintenance Plan are measures of performance of an objective nature that provide insight into the current state of the Operations and Maintenance program.

For each KPI, it is important to understand the performance factors being measured and also the influence of contributing factors. It is advisable to review the Processes and Procedures before drawing performance conclusions based on the KPIs alone.

The current reports and KPIs that the metrics program generates are listed in Appendices K and L. These specific metrics are tailored for the maintenance program and may change as the program develops.

6 CONTROL OF MAINTENANCE ACTIVITIES

Documentation is a key enabler in the Maintenance Organization's ability to achieve its stated goals (Section 4.4). The underlying approach, which defines the documentation, is to develop efficient, value-added, understandable documents that are readily accessible by all workers.

To ensure that Maintenance Documentation is easily accessible to all workers, the documents have been incorporated into the Team NIF Webpage (Section 6.1) and SMaRT database (Section 8.1).

6.1 Maintenance Processes Website

To support a process-based operation, administrative processes and procedures are accessible through the NIF Program intranet within the Team NIF webpage, https://nif-int.llnl.gov/.

The NIF Maintenance Plan is located under the Procedures/Conduct of Maintenance subsection.

6.2 Work-Management Processes

6.2.1 Initiating Work Maintenance Work Flow Process (NIF-0114377)[7]

The requested work process establishes how work enters and is distributed throughout the Maintenance organization (does not include preventive maintenance). This process should be followed to ensure that incoming work requests are tracked and consistently entered into SMaRT. This will also allow work to be assigned to and approved by the appropriate individuals.

6.2.1.1 Maintenance Work Request Procedure (NIF-0113513)[8]

A portion of requested work is created by the NIF Operations Request Line. The Request Line provides an avenue for the maintenance staff and building occupants to submit work requests. Phone calls, emails, LoCoS Problem Logs, and National Nuclear Security Administration (NNSA) safety items are typical submissions. This procedure outlines the Request Line operations and how the Work Order is routed to the correct approver.

6.2.1.2 Maintenance Work Order Approval Procedure (NIF-5021297)[9]

Once a Work Request is transformed into a Work Order, it is routed to the appropriate approver. This procedure outlines the actions of the approver. When the approver reviews the Work Order for priority, he/she may adjust it based on the approver's knowledge of the work and understanding of the priority system.

6.2.1.3 TESA Lock Work Coordination (NIF-5021844)[10]

This procedure identifies the process for which TESA lock repairs, new installations, and moves are coordinated with Plant Engineering through the NIF TESA Team and Locks & Keys. The access lists in the TESA locks are managed through Procedure 5.5, *NIF Access*.[11]

6.2.1.4 PM Work Order Generation (NIF-5021296)[12]

This procedure defines how PM Work is automatically generated from the SMaRT system and distributed throughout the Maintenance organization. The O&M Program produced an equipment hierarchy and complimenting PM Schedule for each CF/BUS System. Figure 6 is a graphical depiction of how these two elements are used together to generate a Work Order (see SMaRT Application Guide on the NIF IT website for more information). A portion of this procedure focuses on the set-up and configuration of SMaRT while other sections define how work is generated, routed, and approved.

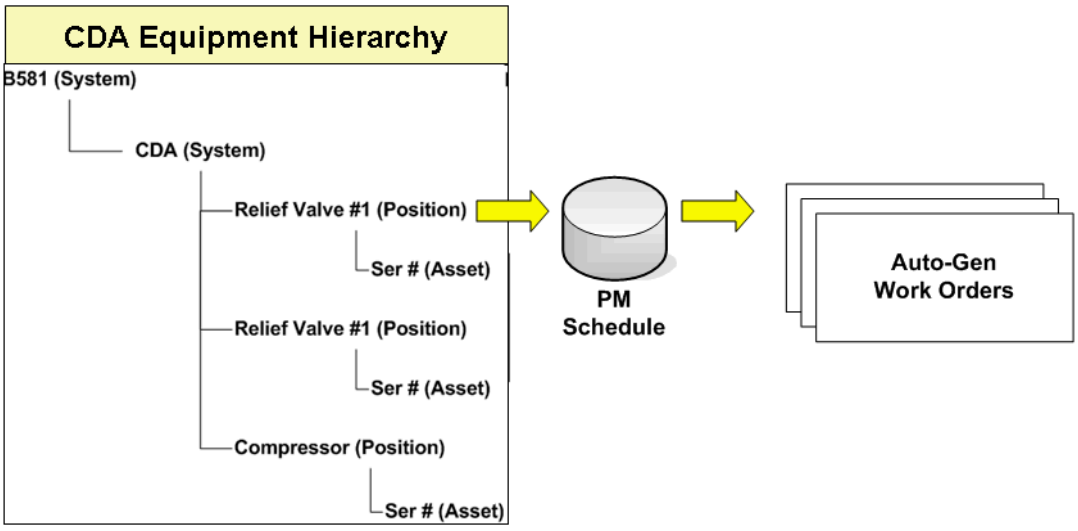


Figure 5. PM Work Order Auto-Generation

6.2.2 Maintenance Internal Operations Work Flow Diagram (NIF-0114615)[13]

Once work has been approved, the work is routed to the Field Managers. The Internal Operations Process describes how work is planned, scheduled, and executed.

6.2.2.1 Maintenance Work Planning and Scheduling (NIF-0113509)[14]

This procedure defines how work activities are planned before work is released into the field for execution. These coordination efforts include a weekly PM/RM meeting with the responsible Field Manager, Subsystem Managers, and Planning and Scheduling where metrics, the current work order status and priorities are discussed. Daily work coordination is also captured in this procedure using a form referred to as the Plan of the Day. This tool is used to assign work to employees and communicate to relevant parties the work that will be performed that day.

6.2.2.2 Maintenance Work Order Execution (NIF-5021295)[15]

This procedure outlines how the Field Supervisor and/or Field Manager hands over a Work Order, once work has been released, to a worker for execution in the Field. He/she answers any questions and reviews the work with the worker when needed. Once the hand-over is complete, the worker documents his/her work and turns the Work Order into his/her Manager.

6.2.2.3 NIF Operations Facility Duty Officer Response (NIF-5018691)[6]

Refer to Section 4.6.3.

6.2.2.4 NIF Operations On-Call Field Supervisor Response (NIF-5018946)[5]

Refer to Section 4.6.2.

6.2.3 Maintenance Work Order Closure Work Flow Process (NIF-0114223)[16]

This process defines how work is closed out after work has been executed in the field. The work is reviewed by the Field Manager before it is submitted to Planning and Scheduling for final close-out. P&S performs a second level of QA as the data is being entered into SMaRT. If the work requires the Subsystem Manager's review the work will be routed to them before final Close-Out (e.g., reviewing re-test results).

6.2.3.1 Maintenance Work Order Close Out Procedure (NIF-5019007)[17]

This procedure describes the process from the time a Technician completes the work in the field through all technical and managerial reviews up until the SMaRT Work Order is closed.

6.3 System Level Maintenance Plans

System level Maintenance Plans contain the specific approach and methods that are designed specifically for each of NIF's approximately 160 subsystems. Through the MQ process, described in Section 19.2, NIF is working to have a maintenance program for each of its subsystems described in a SLMP. The SLMP template can be found on the NIF Procedure Templates webpage (https://nif-int.llnl.gov/procedures_docs_forms/procedure_templates _tools.php).

Because the information contained in a SLMP is extensive, each SLMP is a separate document in ECMS. For a complete listing, refer to Appendix D where SLMPs are listed by the corresponding subsystem with the ECMS number.

SLMPs are a significant portion of NIF's Maintenance Policy and are appended to this maintenance plan by reference. At a minimum, the plan includes:

- Introduction—general or background information about the plan.
- Definitions—unique terms or words.
- System Description—a brief overview of the subsystem adequately describing the physical configuration, major components, and functionality, and operating environment.
- System Components—the components of the subsystem derived from the P&ID drawings or system walkthroughs.
- Subsystem Boundaries/Interfaces—the interfaces and bounds of the subsystem described in the plan, with the goal to not duplicate assets in other subsystems.
- Functional Failures—functional failures are defined as failures of the system or subsystem to provide its intended function or functions to the overall facility. Functional Failure identification is critical to the Reliability-Centered Maintenance (RCM) Process and in the development of the preventive maintenance program. The basis of the RCM Process is that the maintenance performed on the system does not focus on preventing component malfunction, but instead it aims to preserve system function. Therefore, proper function identification and functional failure definition is critical to the Failure Mode and Effects Analysis.
- Failure Mode and Effects Analysis (FMEA)—identifies equipment failure modes and causes to determine their effect on subsystem and facility function. The failure modes, causes, and effects are presented at a level appropriate for determining effective preventive maintenance actions and for eliminating from consideration equipment or failures that have no impact on system function.
- Failure Mode/Cause Categorization—further analysis is performed on the failure modes to prioritize their importance. The results of this analysis are used to eliminate failure modes that do not impact system function or NIF operation so that maintenance resources are not overused on low priority or non-essential equipment.
- Training—describes the training necessary to perform maintenance on the subsystem.
- Periodic Independent Verification—denotes equipment that requires periodic independent verification.

- Task Lists—written to give an outline of the recommended maintenance tasks, the equipment types on which the maintenance tasks will be performed, and the frequency of the tasks.
- Maintenance Implementation—series of maintenance procedures that define the preventive maintenance program for the Subsystem. These maintenance procedures, include their frequency and associated SMaRT PM Task Code.
- Calibration—requirements for the Subsystem instrumentation
- Data Logging requirements—the requirement to maintain a log on a specific parameter in this section.
- Emergency Response Plan—discusses what to do in an emergency and the appropriate response.

6.4 Continuous Improvement

Continuous Improvement is a key element of a maturing maintenance program. Continuous improvement may come from a wide variety of sources and therefore must be properly reviewed for applicability and incorporation into the appropriate process or procedure. The approach to continuous improvement applicable to the maintenance program is reliant on existing processes and procedures and accepted practices as follows:

Table 4. Continuous Improvement Approaches

Continuous Improvement Approach	When is this approach used
Formal Lessons Learned process has been established and is described in the NIF Programs Directorate Procedure: Procedure 5.11, *Management Review.*[18]	All off-normal incidents should be reviewed for the appropriateness and applicability of the Lessons Learned. The following has been excerpted from Procedure 5.11[18] for reference, "for evaluating events or problems using a graded approach for the National Ignition Facility and Photon Science (NIF & PS) Directorate. All events or problems that result in or potentially could have resulted in worker illness or injury, environmental damage, or equipment damage above an incidental value shall be reported and reviewed. NIF & PS Management may also choose to conduct investigations of other types of issues, such as equipment damage, near misses, or unexpected compromises of product quality or work efficiency. Identification of cause to prevent events or problems that occur within the NIF & PS Directorate and the corresponding corrective actions will be the basis of a Management Review to prevent similar future events or problems. As applicable, Management Reviews should be forwarded to the LLNL Lessons Learned program. This procedure defines and implements a graded approach of the causal analysis techniques for events or problems. Events or problems of lower significance and impact are assessed and dealt with to the level of their significance, while incidents of greater importance receive additional investigation and analysis."

Continuous Improvement Approach	When is this approach used
Suggestions for improvement of this Maintenance Plan or the Business Processes incorporated within this document should be routed to NIF Operations Manager or NIF Integration Manager. Changes to documents are reviewed according to requirements stated in the *NIF Operations Management Plan*.[1]	Requested improvements or suggestions for improvements to maintenance documentation which includes: • Corrective Actions resulting from Incident Reports or Lessons Learned • ITS items • Management Self Assessments
Improvement of Subsystem Performance should be routed to the Subsystem Manager (and Configured System Manager as appropriate) Improvements are stated and documented via revisions to the System-level Maintenance Plan, procedures, or other documents as appropriate.	General requested improvements or suggestions for improvements to subsystem performance, which includes: • Corrective Actions resulting from Incident Reports or Lessons Learned • ITS items • Management Self Assessments Field requests, documented on a Work Order, are routed to the Subsystem Manager for review and potential inclusion into program documentation or work practices

6.5 Controlling Maintenance on Configured Systems

6.5.1 NIF's Technical Subsystems and Configured Systems

For the purpose of managing work and appropriately applying the necessary controls in the performance of the work, NIF has designated two types of systems:

- Subsystems or Technical Subsystems.
- Configured Systems.

A Technical Subsystem is comprised of lower-level subsystems and individual equipment or assets that work together or are otherwise related either functionally or for reporting. These assets may or may not have a safety-related function. Configured Systems are a functional system. That is, the equipment and assets contained within the Configured System perform a specific safety function. It is important to remember that equipment assets can be contained both within a Technical Subsystem and a Configured System.

Several of NIF's 150 Technical Subsystems support the functionality of NIF's Configured Systems. Knowing which subsystems contain Configuration Items is important to understanding NIF's approach to maintaining the functionality of the Configured Systems. To enable identification of CIs during work order processing, SMaRT contains a Safety/CI flag which is set if the equipment may contain a CI or if work on the equipment may affect a CI. Note, however, that the final determination as to whether the work actually affects a CI is through the Work Control process as documented in NIF Project Control Procedure 5.8, *Work Permits*.[19]

A comprehensive list of technical subsystems and the relation to Configured Systems can be located in the Unified System Heirarchy.[4]

For general information on Configuration Management and configured systems, refer to the *NIF Configuration Management Plan* (CMP).[20]

For a list of Configured Systems, refer to the *NIF Configured Systems and Configured Item List*.[21]

6.6 Documentation Required for Maintenance on Subsystems

NIF's maintenance approach to documentation is dependent on whether the work is performed on a subsystem or equipment contains/is a Configuration Item. NIF's approach for maintenance on Configured Systems relies on maintaining a higher level of situational awareness and other restrictions. The approach to work on subsystems and the additional restrictions for work on Subsystems containing CIs are shown in the following table:

Table 5. Maintenance Work Documentation

Maintenance Work on NIF Equipment		
Documentation Approach	**Maintained equipment does not contain CIs**	**Maintained equipment contains CIs**
Work Order routing	Work order may be routed through the Subsystem Manager for review after work completion Note: Implementation of SMaRT is via the *Maintenance Implementation Plan*[3]	All Work Orders are routed through Subsystem Manager for approval after work completion Note: Implementation of SMaRT is via the *Maintenance Implementation Plan*[3]
Work Order	Standard header	The Work Order contains an attribute "Safety/CI" that is checked
SLMPs	Refer to this Maintenance Plan, Section 6.3 Note: Implementation of SLMPs is per the schedule contained in the *Maintenance Implementation Plan*[3]	The SLMP will contain the following statement: *This system-level maintenance plan (may or does) contain references to Configuration Items or affects work performed on Configuration Items. For the list of Configuration Items, refer to NIF-5######* in ECMS."* *Refer to *NIF Configured Systems and Configured Item List*[21] for selection.
Configured System Maintenance Plan (CSMP)	Not applicable	Required
Work Permit	See procedure *NIF Work Permits*[19]	See procedure *NIF Work Permits*[19]
Maintenance Procedure	Controlled in accordance with *Configuration Management Plan*[20]	Controlled in accordance with *Configuration Management Plan*[20] as a Configuration Item
Independent Verification (refer to this Maintenance Plan, Section 14)	Stated on the Work Order/Work Procedure only if it is required by the Subsystem Manager	Stated on the Work Order/Work Procedure The requirement for Independent Verification is contained in the CI List and contained in the SLMP
Post Maintenance Testing (refer to this Maintenance Plan, Section 10)	Only if required by Subsystem Manager Retesting of the component IF REQUIRED will be shown on the Work Permit under "Retest" The Maintenance Procedure may provide guidance on how the retest is to	Required. Retesting of the component IS REQUIRED and will be shown on the Work Permit under "Retest". The Maintenance Procedure may provide guidance on how the retest is to be performed

Maintenance Work on NIF Equipment		
Documentation Approach	**Maintained equipment does not contain CIs**	**Maintained equipment contains CIs**
	be performed	Refer to Section 10 for further information

6.7 Defining Maintenance to Support Configured System Functionality

The specific maintenance required to maintain the functionality of the Configured System is included in the Configured System Maintenance Plan (CSMP). The primary purpose of the CSMP is to document the critical functions and how they are being assured.

As indicated in Section 6.3, SLMPs contain the maintenance approach, schedule and maintenance procedures for the technical subsystem. The specific maintenance requirements for Configuration Items are described in the CSMP and enabled in the maintenance procedures listed in the SLMP. In other words, the CSMP drives the requirements and the SLMP executes the requirements through the associated maintenance procedures. The table below denotes the specific actions denoted in each document

Table 6. SLMPs and CSMPs

SLMP	CSMP
Refer to Section 6.3 for specific information. In summary, contains the approach, procedures, and checklists to support and maintain the reliability of the Technical Subsystem in support of the functionality of the Configured System.	The primary purpose of the CSMP is to document the critical functions and how they are being assured. CSMPs make use of and refer to SLMPs, maintenance procedures and checklists. Specific sections of the CSMP pertaining to Maintenance include: • Description of maintenance required. • Statement of the maintenance being performed on the sub-system (including references to applicable SLMPs, procedures, and/or checklists, if available). • Statement of required inspections by the Configured System Manager.

6.8 Executing Maintenance Which Affects Technical Subsystems Containing CIs

The following actions are taken when work is being performed on a Configuration Item:

- Work Order:
    - If the procedure is a CI then, the Work Order will contain the required Qualifications for workers.
    - If the procedure is not a CI, then the Work Order may contain the required Qualifications for workers.

      Note: Implementation of SMaRT is via the Maintenance Implementation Plan.[3]
- Work Permit:
    - Work Permit states if a CI is involved.
    - Impairment controls may be required if a CI is involved.

- Daily Work Team Meeting:
    - WPRI and/or DWTL discuss work on the CI in the Daily Work team meeting (SPA meeting).
    - WPRI and/or DWTL discuss impairment controls at SPA.
- Work Team:
    - Performs work exactly in accordance with the Work Permit, Work Order, and written work procedures.
    - If work cannot be accomplished exactly as planned, STOP work immediately and notify the DWTL.
    - Work shall not proceed until the issue has been resolved and documented on the Work Order Closeout form.
    - Examples when the DWTL should be notified:
        - Procedure is incorrect:
        - Drawing is incorrect—does not match field conditions.
        - The exact, specified part is not available.
- Required notifications:
    - DWTL shall notify Subsystem Manager and Configured System Manager if any of the above conditions exist.
- After Work is Completed:
    - The Configured System Manager shall review testing (RETEST on Work Permit) and close out the work permit.
    - The Subsystem Manager shall review the Work Order in SMaRT and move the Work Order from “Review for Closeout” to “Closeout”.

6.9 Operating Logs

As documented in the *NIF Operations Management Plan*,[1] Operating Logs are the record of events in the facility and provide a history of facility status. Operating logs are documents upon which operating information is entered for potential use to identify performance trends or off-normal conditions. The logs are also a retrievable record for use in Lessons Learned or to better understand the events leading up to an off-normal condition.

Operating Logs used for Facility equipment should, as a minimum, include:

- Sufficient space for entry of operating values (i.e., number or text).
- Operating limits for each entry as appropriate.

Systems and the associated equipment shall be reviewed by the responsible Subsystem Manager with the intent of identifying items or information for log keeping. A parameter or item should be manually logged if any of the following conditions are met:

- The parameter or item is a CI
    - and it is a variable process output;
    - and the value is not otherwise logged by Industrial Controls System (ICS), Direct Digital Control (DDC) ; or Integrated Computers and Controls (ICCS).
- The parameter or item is a requirement as noted in RMS.
- The parameter or item is a requirement as required by regulatory agencies.

The Subsystem Manager should document the requirement to maintain a log on a specific parameter in the System-level Maintenance Plan.

The Subsystem Manager will review the logbooks at least weekly for abnormal occurrences and/or readings. Abnormal readings are those values that are outside the Parameter's Operating Limits.

The Operator or Technician taking the log readings should:

- Clearly and legibly record data.
- Correct erroneous entries by striking through the entry and noting their name and date. If corrected information is available, the Operator or Technician should include this in the log.
- Provide feedback to the CF/BUS Field Manager when any situation prevented the taking of logs as scheduled.
- Promptly contact NIF management when out-of-tolerance readings are taken.
- Denote out-of-tolerance readings by circling the value AND/OR with notes on the log sheet.

The CF/BUS Field Managers should review the logbooks at least weekly for the following:

- Logs are performed per a set schedule (usually daily) and entries are made immediately.
- Logbook entries are legible and easily understood.
- Entries on the completed Logs may be found to be erroneous. The Field Manager or the Subsystem Manager will review the value with the Technician/Operator who recorded the log. The Tech/Operator, upon agreement, will then correct the erroneous data by striking through the entry, adding initials, and dating. If corrected information is available, the Operator/Tech should include this in the log.

The CF/BUS Field Managers shall review the log books at least monthly for the following:

- Conformance with logbook-keeping requirements as indicated in Table 7.

Table 7. Operating Logs Maintained by the CF/BUS O&M Groups

Logbook	Logbook Location	Logged By/Log	Amplifying information
Daily Log	Form/Records in O&M Document Control	BUS O&M Technician	Plan to move into an electronic form in FY2009
Daily Log Template	Located in ECMS as NIF-5020941	Not Applicable	None

6.10 Maintenance Logs

Maintenance logs are the record of the maintenance work performed on a system or equipment.

As all maintenance records are maintained in SMaRT, the work performed by the CF/BUS COM is documented on a SMaRT Work Order. These Work Orders include data fields that allow the technician or Subsystem Manager to attach the Work Order to system or equipment assets. By doing this, the process of filling out a Work Order is effectively the log of work performed on that particular system. Custom reports of the work performed on the system can also be generated, which results in a highly customizable logbook.

The Planning and Scheduling group, through the Work Order close-out process, reviews the completed Work Orders (paper copy) and enters the information into SMaRT. P&S ensures that the information is readable and complete. P&S shall contact the Field Manager for clarification on information that is illegible or incomplete. If a Subsystem Manager's review is required, the Work Order will be routed to him/her to complete the review (see Section 6.2.3).

Entries on the completed Work Order may be found to be erroneous. The Subsystem Manager will correct the erroneous data during the Work Order Close-out Procedure (refer to Section 6.2.3) either by deleting or striking through the entry. If corrected information is available, the Subsystem Manager may include this in the documentation. All deletions, strikethroughs, and corrected entries should be noted electronically using SMaRT in the Work Order—Closing Comments Tab.

For this process to be fully effective, the Work Order closeout process should be performed within five days of completion of the Work Order.

Table 8. Maintenance Logs Maintained by the CF/BUS O&M Groups

Logbook	Log Template File Location	Logbook Location	Logged By/Log	Amplifying information
General Maintenance Log	Not Applicable	SMaRT	Refer to Section 8	Refer to Section 8
Facility Inspection and Daily Log	NIF-5024364	B581—Diag Bldg, R1006	CF O&M Technician	Replaces Central Plant/Boilers daily log, daily Cooling Tower log, daily Chiller log, Mech Rm log, OAB Mech Rom Log
Boiler and Generator Air Quality Log (BAAQMD)	Spreadsheet Initiated via email from EPD to FPOC, monthly	B682 and Generators	CF O&M Technician or LLNL Electrician or Operator Reporting to EPD by FPOC	Performed Monthly Information provided to EPD
Cooling Tower Water Treatment	At Cooling Tower	LLNL Watershop	LLNL Watershop	Off-normal conditions Weekly reports submitted to TW Subsystem Manager
Refrigerant Usage Log	Book located at Chiller	B682—at each Chiller	CF O&M Technician w/ subcontractor assistance	Environmental reporting

6.11 Operator Aids

The use of Posted Operator Aids such as equipment set points, diagrams, and procedures, where such posting are the actual guidance for operating the system, should in general be discouraged; however, if needed, the following guidelines apply.

6.11.1 Determining the Need for Operator Aids

For all systems containing CIs, the responsible Subsystem Manager will review the operation of the system with the Field Manager to ensure understanding of the system's technical performance. For instances in which a quick reference is needed to reinforce system understanding but the level of detail provided in the Maintenance Plan or Operating Procedures is not required or practical, then the Subsystem Manager will develop a proposed Operator Aid.

6.11.2 Receiving Approval for Operator Aids

- The Subsystem Manager together with the Field Manager shall review proposed Operator Aid with the affected workers, incorporating their comments to ensure understanding.
- The Subsystem Manager shall review the proposed Operator Aid with the CF/BUS COM Manager.
- The Subsystem Manager shall receive approval from the NIF Operations Manager to publish and post the Operator Aid.
- Additional guidance on Operator Aids including approval and updates, and a complete listing of aids can be found in the *NIF Shot Operations Plan*.[2]

6.12 Work Centers

Work centers are defined as physical locations within the NIF. At these centers, workers obtain the material (parts, consumable items, including clean construction protocol [CCP]), tools, and work procedures necessary to perform a Work Order. These centers are positioned to allow convenient accessibility to the eventual workplace.

The work centers are at the following locations:

- B581—Diagnostic Bldg, 1st Floor, near the elevator, tool crib, and warehouse.
- B581—Diagnostic Bldg, 3rd Floor, near the elevator, tool crib, and warehouse.
- B581—Mechanical Room—Level 3.

6.13 Interface Between Planning and Scheduling and Logistics

The Planning and Scheduling and Material Management group shall work together to ensure that all preventive maintenance work orders have parts available for work completion. When a Preventive Maintenance Work Order is generated from SMaRT it will include a written procedure, tool and material list required to perform the work. The P&S Planner will ensure that these parts are available in the Glovia system by writing a Glovia Work Order. This will supply the Inventory Clerk with a material order to be filled for the coinciding SMaRT maintenance work order. The P&S Planner will define the required date in Glovia to be in sync with the SMaRT Scheduled Start Date.

NIF is planning to integrate SMaRT and Glovia so that SMaRT would create a Glovia Work Order to create the demand for the material and tool required. Further enhancements may result in Glovia updating SMaRT with delivery status and SMaRT adjusting the scheduled start date to coincide with part delivery.

The SMaRT Maintenance Work Order and attached documents (e.g., procedures) are then distributed to the DWTL from their Manager or Supervisor communicating the details of work to be performed.

For reactive Work Orders, a material request will be filled out by the P&S Planner or the DWTL and submitted manually to the inventory clerk and/or tool crib Coordinator.

6.14 Record Filing and Archiving

Master documents generated as a result of implementing this maintenance plan (processes, procedures, work instructions, checklists) shall be controlled online within the NIF ECMS System and be available for electronic viewing.

The primary location for documenting maintenance work performed (including inspection reports, etc.) is SMaRT. This assures readily available and retrievable records. Documentation of work performed on equipment assets is searchable by using the equipment asset name or Work Order number.

Any additional records, if required, are identified in the specific *Maintenance Documentation and Record Filing* procedure (NIF-0114507).[22]

Completed Plans of the Day (PODs) and shift turnover checklists should be given to the O&M Administrative Assistant at the completion of each shift. The Administrative Assistant will file the documents either electronically or by paper in the Document Library.

Table 9. Record Retention Requirements

Records	Retention Requirement	Record Location
Work Orders	Life of Facility	SMaRT
Equipment Inspections	Life of Facility	SMaRT, O&M Document Control
All other documents	Refer to the *NIF Operations Management Plan*[1]	

6.15 Maintenance Periods

In order to better plan and coordinate maintenance activities with shot activities, NIF has defined the following maintenance periods:

- Type 1 – Maintenance activities that are integrated with shot operations with the work usually completed in one twelve-hour shift.
- Type 2 – Maintenance activities that can be completed in less than six twelve-hour shifts (less than three days) with some affects on shot operations depending on details of the specific activity.
- Type 3 – Maintenance activities that takes longer than six twelve-hour shifts (more than three days) to complete significant facility maintenance and reconfiguration activities. During Type 3 activities shot operations will be significantly affected.

Campaign schedules are integrated into Type 2 and Type 3 maintenance periods to maximize NIF operations. Typically, one Type 2 maintenance period lasting three days is scheduled per month and one Type 3 maintenance period is scheduled every three to six months. The duration of the Type 3 maintenance period is determined by campaign and facility requirements. Type 1 maintenance activities are non-interfering and can be performed anytime.

7 MAINTENANCE PROCEDURES

7.1 Procedure Development and Writing

Information about requirements for, preparing, reviewing, approving, controlling, distributing, revising, and using NIF Operations procedures for operations and maintenance within the NIF Complex, refer to NIF Procedure 5.14, *Preparation, Content, and Distribution of Operations Procedures*[23] and the *The NIF Management Procedures: Index and Writer's Guide*.[24]

For additional guidance on writing new maintenance procedures and updating existing maintenance procedures, the reader should refer to Appendix I.

A Maintenance and Operating Procedure affecting a Configuration Item shall be controlled as a Configuration-Managed document in accordance with the *NIF Configuration Management Plan*.[20] Additionally, for procedures affecting CI Items, the minimum content shall include:

- Required tools.
- Required training or Qualification Card completion.
- "Correct positioning" notations—e.g., statements in the procedure that clearly state either (1) the correct meter or gauge (e.g., gpm, psi) reading, or (2) the position of components (e.g., stroke or distance) for those CI items or facility equipment that must be within a certain range or position for proper operation.

All Operating and Maintenance procedures shall be field verified before use. Refer to Section 7.3 for further information. (CON OPS requirement)

Preventive Maintenance procedures are documented in ECMS and are made available in the work area for use and reference by workers through the SMaRT system. After preparation, review, and approval, all Preventive Maintenance procedures are documented in ECMS.

Preventive maintenance procedures are documented in ECMS and are made available in the work area for use and reference by workers through SMaRT. This works because SMaRT contains the preventive maintenance tasks and the schedule for executing the tasks. Each maintenance task is associated with a preventive maintenance procedure in ECMS. When a task is scheduled by SMaRT, a Work Order is generated with the procedure from ECMS attached. See Section 8.1 for more information.

7.2 Procedure Verification

Verification is the review of a new or revised procedure to determine whether it is technically accurate and properly arranged. This review should ensure that the procedure incorporates human factors principles and appropriate administrative policies. The technical accuracy review should also include a review of the procedure against the design requirement for the system or component it concerns. This may be accomplished by comparing the vendor manual and design specifications to the procedure.

Verification should be conducted by one or more reviewers who were not involved in writing the procedure. Reviewers from other disciplines, such as health physics, engineering, and operations, should also be considered for involvement in the process.

Reviewers are included in the routing of the procedure in ECMS. Refer to NIF Project Control Procedure 5.14, *Preparation, Content, and Distribution of Operations Procedures,*[23] and 11.1, *The NIF Management Procedures: Index and Writers Guide*,[24] for review requirements.

7.3 Procedure Validation

Validation is review of a procedure to determine its usability and correctness. This review evaluates whether the procedure provides sufficient and understandable guidance and direction to the personnel and that it is compatible with the equipment or subsystem being maintained. Validation may be conducted in the field, shop, or in a training environment.

All Preventive Maintenance procedures shall be validated before use. Refer to Appendix I, Guidelines for Writing System Level Maintenance Plans and Maintenance Procedures, for further information. If the procedure has not been validated, then the procedure should be performed in the presence of the subsystem manager. Procedures that have not been validated should contain special text immediately beneath the header requiring the Subsystem Manager to be present when the work is performed. Once a procedure has been validated, the subsystem manager's presence may not be required.

Procedures that are released in ECMS and have not been validated may be identified with the version being "AA" and the note stating that a subsystem manager must be present for the work to commence. Procedures with versions "AB" or higher, generally, have been field validated.

7.4 Procedure Approval

Preventive maintenance procedures are approved in accordance with NIF Procedure 5.14, *Preparation, Content, and Distribution of Operations Procedures,*[23] and NIF Procedure 11.1, *The NIF Management Procedures: Index and Writers Guide*.[24]

7.5 Procedure Use

The requirements for the need for and use of procedures should be clearly defined and understood by all operators and maintainers. Operators and maintainers should also have procedures with them when performing work and follow them in a step-by-step manner. The guidelines for determining if a procedure is "Continuous Use," "General Use," or "Reference Only" are in NIF Procedure 5.14, *Preparation, Content, and Distribution of Operations Procedures*.[23] The appropriate Use Category is identified at the beginning of each procedure in accordance with the NIF Procedure 11.1, *The NIF Management Procedures: Index and Writers Guide*.[24]

In nearly all instances, procedures are required when performing work on NIF's subsystems and will be provided for all maintenance being performed under the following conditions:

- **High consequence of failure:** When failure to correctly perform a specific sequence of steps for an activity would likely result in high consequences to the project, environment, safety, and health.
- **Complex work activity:** When a work activity is so complex that authorized and qualified workers may not successfully and safely complete it without a procedure. Examples are:
    - Detailed activities where repeatability or a high degree of quality is critical.
    - Maintenance work on "Configuration Items."
- **Infrequent Performance:** When moderately complex activities are not routinely performed. Examples include:
    - Long duration between activities that require a high degree of skill.
    - Emergency response activities.

- **Operations Involving Workers with Limited Experience:** When deemed necessary for work activities that involve personnel who have little related experience with the particular work and its controls. Examples may include:
    - Work performed by workers new to the activity.
    - Work performed by workers that are from a vendor, subcontractor, working under a PWS, or non-NIF IWS.
    - Work done by temporary workers, such as summer workers and guest.

In exception to this policy, operators may take whatever action is necessary during emergency conditions to place the facility in a safe condition and to protect equipment, personnel, and public safety without first initiating a procedure change. Operators need not reference emergency procedures during the performance of immediate actions since these actions are committed to memory; however, the emergency procedure immediate action instructions should be reviewed after the actions are performed, thus verifying that all required actions have been taken.

7.6 Correcting Deficient Maintenance Procedures

If procedures are found to be deficient during the performance of that procedure, a request to change the procedure should be given to the appropriate manager.

7.7 Procedure Change Control, Periodic Review, and Revision

Change control, periodic review, and revision are performed in accordance with NIF Project Control Procedure 5.14, *Preparation, Content, and Distribution of Operations Procedures,*[23] and 11.1, *The NIF Management Procedures: Index and Writers Guide*.[24]

Changes to Maintenance Procedures, under Configuration Management, shall be performed in accordance with NIF Procedure 6.4, *Control of CM Documents*.[25]

Changes to the procedures may be the result of feedback from the technician performing the procedure. This feedback may be in the form of corrections or suggestions for procedure improvement. This may be via the use of red-lines on the procedure. In all cases, the Subsystem Manager will receive any field comments made regarding the procedure. Refer to the *Maintenance Work Order Close Out Procedure*.[17]

7.8 Preventive/Situational Maintenance Code Naming Procedure

NIF Operations has established a procedure to define the process for naming Preventive Maintenance Codes within the SMaRT system (*SMaRT Preventive Maintenance Naming Standards*[26]). While not required, this naming standard is highly recommended as it provides a quick visualization as to the subsystem and frequency at which the procedure is performed.

7.9 Linking Preventive Maintenance Procedures to the PM Schedule

Preventive maintenance tasks are generated according to a defined schedule. SMaRT contains all preventive maintenance tasks and the schedule for executing these tasks. When SMART generates a task, a Work Order is generated. Each maintenance task is associated with a preventive maintenance procedure (see Section 5.3.2). The maintenance procedures, contained in ECMS, are recalled by SMaRT and attached to the Work Order. The Work Order, containing the current version of the procedure, is then forwarded to the Field Manager or Supervisor.

8 MAINTENANCE HISTORY PROGRAM

8.1 SMaRT

SMaRT is the Computerized Maintenance Management System that contains information to enable the processes necessary in order to perform maintenance on NIF subsystems.

SMaRT is on the NIF Intranet in the NIFIT section. Its main page is shown in the adjacent figure.

SMaRT tracks work that is performed and retains the records of work performed. To enable and provide assurance that all work is accordingly tracked and recorded, the following policies are in place:

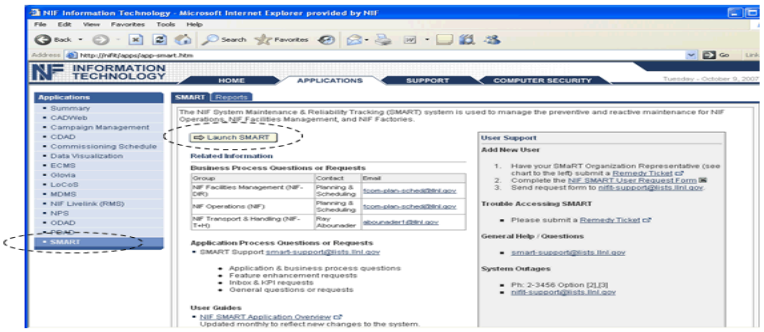


Figure 6. SMaRT Main Page

- A Work Order is required to perform work.
- Work Orders should contain procedures to perform the work.
- A Work Order does not serve as an authorizing document.
- A Work Permit (LoCoS) is the only authorization process for work. It contains the specific instructions, approval signatures, and necessary Credited Safety System (CSS) impairments.
- A Work Order provides a mechanism for written feedback to the Subsystem Manager and Work Requestor.
- All Work Orders shall be closed-out by the Planning and Scheduling group.
- All Work Orders shall be approved before work is planned, scheduled, or performed by the Subsystem Manager or Facility Point of Contact (FPOC).
- All completed Work Orders on Configuration Items (CIs) shall be routed to the Subsystem Manager for review before close-out.

SMaRT is configured based on the work-management procedures and processes listed in Section 6.2. SMaRT's primary role is to support the administrative function of the maintenance organization as listed above and shown in the flowchart. In this way, SMaRT works to increase organization efficiency and compliance with stated procedures.

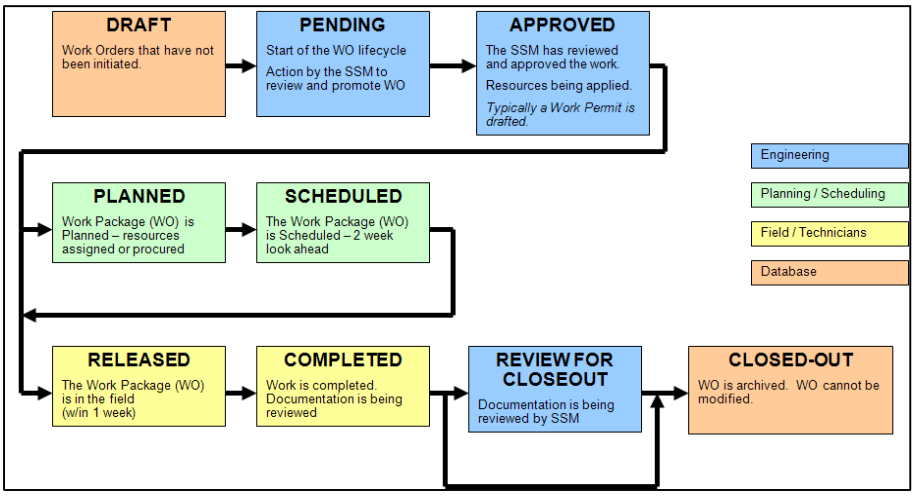


Figure 7. Maintenance Administrative Functions

8.1.1 SMaRT Application Reference

SMaRT is owned and maintained by the NIF Information Technology group.

The reference for the Application and its embedded processes is contained in the *SMART Application Guide*.[27]

8.1.2 Changes or Modifications to SMaRT Database

Modifications to the SMART database are necessary in order to support the requirements of a maintenance program. The requested changes are made according to a defined process. The process for making the change begins with a definition of requirements by the NIF Operations organization. As database changes may affect reports and metrics, however, careful consideration should be made before making a change. Upon approval of the requested change, the Change Request is forwarded to the NIF IT Organization, where database changes are performed according to the NIF IT organization's processes.

8.1.2.1 SMaRT Change Request (NIF-5021714[28])

This procedure defines how the SMaRT's Equipment Hierarchies and PM schedules are generated and modified in support of NIF's Configuration Management process.

8.2 Program Development

All equipment contained in the MEL and loaded into SMaRT are available for attaching documents and assigning historical data. NIF's approach to attaching equipment history to equipment is to define that association directly on the maintenance procedure. The completed maintenance documentation is attached according to the table in the Maintenance Procedure, Section 1.0. Effectively, SMaRT links the completed maintenance history record to the Equipment, the Work Order, and the Preventive Maintenance schedule under which the work was performed.

Data Identification: NIF collects and records equipment data as follows:

- Corrective maintenance records.
- Preventive Maintenance records.
- Modification packages.
- Vendor repair information (e.g., correspondence on component repairs and modification bulletins).
- Start-up tests and other baseline data.
- Appropriate surveillance test data.
- Calibration data.
- Applicable industry experience information.

The specific data recorded includes details of the work performed, special equipment and tools used, procedures or drawings needed, spare parts installed, personnel safety and radiation protection requirements, post-maintenance testing results, and other information that may be useful later.

8.2.1 Data Collection

Data on CIs selected for history retention is sent to the Subsystem Manager for review. The Subsystem Manager's concurrence with its entry into the maintenance history program is part of the Work Order Closeout process. Any apparent errors, inconsistencies, or lack of detail is referred to the Field Manager or Field Supervisor (i.e. maintenance supervisor) for resolution.

8.3 Maintenance History File Development

Normally, components are grouped by subsystem; however, in cases of like components such as valves, circuit breakers, and controllers, it may be appropriate to also group those components by type. In SMaRT, this is known as the Class/Category designation (refer to Section 8.4.3).

The maintenance history file for each component should include the following four sections:

Component Identification and Description. Subsystem Managers should ensure each component is identified by its name and number as listed in the MEL. When working from a SMART Work Order, this information is contained on the Work Order header and denotes not only the component name but also the complete hierarchy path.

In the case of like components grouped by Class/Category, this may be an index of all individual components and their associated subsystems.

Also, the SMART Equipment Object record (viewable from within the SMART application) contains the manufacturer's name, model, serial number, and priority classification. Additional reference may include the associated "N number", vendor manuals; drawings; P&ID drawings, acquisition data (i.e., purchase information and date accepted); location (building and room numbers); applicable engineering documents; operating requirements/characteristics/history; and spare parts lists; owner/operator documents; and applicable maintenance procedures.

In the event the component is replaced with a new Asset (refer to Section 8.4.2) or modified, the original record is annotated to indicate the change and retained in the maintenance history database. A new record, containing information on the new Asset or modified component, is placed into the maintenance history database.

Maintenance Record. The maintenance record is a chronological record of all significant work performed. All maintenance records are available in SMART via the web reports page or directly from within the application.

For an individual work task, the maintenance record is the Work Package which contains the Maintenance Procedure and Work Closeout documents. The Field Manager or designee extracts the information from the work package during the initial review of completed work and documents the as-found and as-left conditions. The Work Closeout Form should include the date, Work Order number, and a clear, concise statement describing the deficiency and corrective action, with reference to post-maintenance testing results, as-found and as-left data, parts replaced or repaired, special tools used, and craft-resource-hours. Refer to the *Maintenance Work Order Close Out Procedure* (NIF-5019007)[17] for the exact information required.

In the event the component is one of several grouped by type, the component identification is included. Similar entries are made in the event deficiencies are noted and corrective action taken when performing PM or surveillance tests.

Diagnostic Monitoring Data. This record contains all performance-related information derived from baseline tests and checkout data, preventive and predictive maintenance, surveillance tests, and Post-maintenance Testing. Subsystem Managers should review completed documents including

Commissioning Test Reports and operating logs and ensure data are analyzed and recorded. Trending of data (e.g., vibration levels) should be used whenever feasible to facilitate analysis.

Vendor Correspondence. This section contains correspondence, inspections, and test results received from the vendor that relate to routine or PM servicing, parts, changes to as-built drawings, etc. Subsystem Managers should review this information and ensure it is filed and properly applied. Typically, this information is filed in ECMS and linked to the Equipment Object in SMaRT for quick reference.

8.4 SMaRT's Data Structure

8.4.1 Hierarchies

A Subsystem is comprised of lower-level subsystems and individual equipment or assets. Describing the content of these subsystems is best performed by describing the assets that comprise the subsystem.

It should be noted that the full scope of the subsystem also contains other mechanical, electrical, or structural components such as interconnecting piping, control wiring, and miscellaneous components. Subsystem piping and instrumentation diagram (P&ID) drawings are used to represent the subsystem's function in a logical manner.

A complete asset list would be impractical to maintain. Therefore, the asset list was limited to only the maintainable assets. The physical extent or limits of the subsystem is termed the Subsystem Boundary. Establishing and describing the Subsystem Boundaries is necessary to prevent duplication of assets in the equipment database. The subsystem is thereby described by listing the maintainable equipment assets in an organized manner. This description is documented and known as the Technical Hierarchy. The CF and BUS Subsystems and their corresponding Technical Hierarchies are listed in Table 1.

Subsystems also interconnect with other subsystems. These interface points are where piping or wiring crosses Subsystem Boundaries and are termed Subsystem Interfaces. Understanding the interfaces helps to define the interrelationships between the subsystems in the equipment database when establishing an equipment hierarchy.

The Technical Hierarchy may be structured in a number of forms, two of which are discussed in this plan. Most hierarchies are based on a metrics-reporting basis. In this approach, equipment assets are grouped by readily identifiable equipment, structures, or subsystems. Using this approach allows NIF Management to select metrics at each level of the Technical Hierarchy or equipment group.

Another hierarchy form is "Functional." This type of hierarchy is structured based on the physical relationships between equipment assets. The Functional Hierarchy may be used to understand the impact of shutting down specific equipment on other systems or other aspects of the Configured System. The example in which NIF may leverage this capability is in the Electrical Utility System (EUS). The Functional Hierarchy could provide a list of electrical distribution panels fed from a specific transformer. The distribution panel may be connected to a motor in the Heating, Ventilation, and Air Conditioning (HVAC) System, and it is the crossing of the system boundaries (i.e., EUS to HVAC) that defines a system interface.

At the highest level, NIF's subsystems, equipment, and assets are organized into a consistent structure denoted the Unified System Hierarchy.[4] For further information on the Unified System Hierarchy refer to the *NIF Operations Management Plan*.[1]

Hierarchies are organized by Subsystem. The Subsystem name, from the Unified System Hierarchy, is the highest-node for each hierarchy wholly contained within SMaRT. A current hierarchy is obtained through the SMART Interim Webreports via the URL http://duxbury.llnl.gov:7778/web/nif/equip_hier_search.jsp.

8.4.2 Systems, Positions, Assets

Equipment objects are entities upon which data is store and work orders are attached. Equipment can be of many different types, but the four main types are locations, systems, positions, and assets.

- Systems—Collections of positions and/or assets that work together or are otherwise related either functionally or for reporting.
- Locations—Physical locations of systems, positions, and assets. For example, a pump is located in B581-TWC-PAD.

  Note: Locations are rarely used in SMaRT today; instead, the necessary information is contained within the System or Position as an attribute.
- Positions—Functions performed by a general kind of asset. For example, the pump that moves water from one tank to another is a functional position, which can be filled by any number of actual, physical pumps (assets).
- Assets—These are the tangible, physical objects. Assets are the base unit of equipment information and typically are serialized (contains a serial number).

Locations, systems, positions, and assets form a hierarchy of equipment information, with locations at the top of the hierarchy and assets at the bottom. Data is shared among the levels of the equipment hierarchy. For example, data for a work order performed on an asset is also stored in the position, system, and location equipment to which the asset belongs. This data sharing allows tracking of assets and their performance in detail and under differing conditions, to evaluate the performance of entire systems, and to assess the effect that locations and positions have on systems and assets.

8.4.3 Work Orders

A Work Order is a means of obtaining maintenance services available on both paper and electronic mediums and initiated by maintenance customers. Issued to Maintenance Planners and Estimators and used to define, plan, and execute maintenance activities. Documentation of a deficient equipment condition, requires detailed documentation of work performed, spare parts, procedures, or testing to verify maintenance was performed correctly. The completed Work Order and its associated documentation also serves as documentation for completion of maintenance activities.

The fields, features, and attributes of the Work Order are described in this section.

8.4.3.1 Description

The Description is either entered by the user or automatically populated if it is generated from a Preventive Maintenance Schedule. The Description should be an actionable statement. Problem or failure oriented statements should be avoided.

8.4.3.2 Equipment Number

The system, position, or asset (refer to 8.4.2) where the Work Order will be assigned. The Equipment Number will also set certain fields on the Work Order, i.e. Safety/CI flag.

When opening a new Work Order, the user should work to select the Equipment Number first before populating any other fields on the Work Order.

8.4.3.3 WO Status

WO Status is the current *State* of the Work Order. Work Orders move through pre-defined *states* according to pre-defined business rules for managing Work Orders. The business processes are described in Section 6.2. The most common states most users will encounter are:

Table 10. Work Order Status

State (see note)	Status	Action usually performed to move out of the current state
Draft	Work Orders that have not been initiated or generated	Either the SMaRT Administrator manually or the SMaRT application automatically generates Work Orders based on rules—refer to *SMART Application Guide*.[27]
Pending	Start of the Work Order lifecycle.	Subsystem manager reviews and promotes.
Approved	Resources are being checked for availability and applied to the Work Order.	Planner assembles resources and promotes.
Planned	Work Package has all resources available and is being scheduled.	The Planner working with the Scheduler and Field Manager will schedule and promote.
Scheduled	Work Package is scheduled to be performed—typically within 2 weeks.	The Planner working with the Scheduler and Field Manager will schedule and promote.
Released	Work Package is in the field to be performed per the schedule—typically within 1 week	The Field Manager will check progress on the Work Order and when complete will promote.
Work Completed	Work is completed. Documentation is being assembled and processed.	The Planner and the Field Manager will assemble the documentation and promote.
Review for Closeout	Completed Work Package is being reviewed by the Subsystem manager.	Subsystem manager reviews and promotes.
Closed Out	Work Order package is archived and cannot be modified.	None
Note: See the *SMaRT Application Guide*[27] for a complete list.		

The relationship of the most often used *states* and a typical Work Order progression for NIF Operations is shown in the following graphic. Note, however, the exact progression of a Work Order is subject to the various business rules is described in Section 6.2 and specified in rigorous detail in the *SMART Application Guide*.[27]

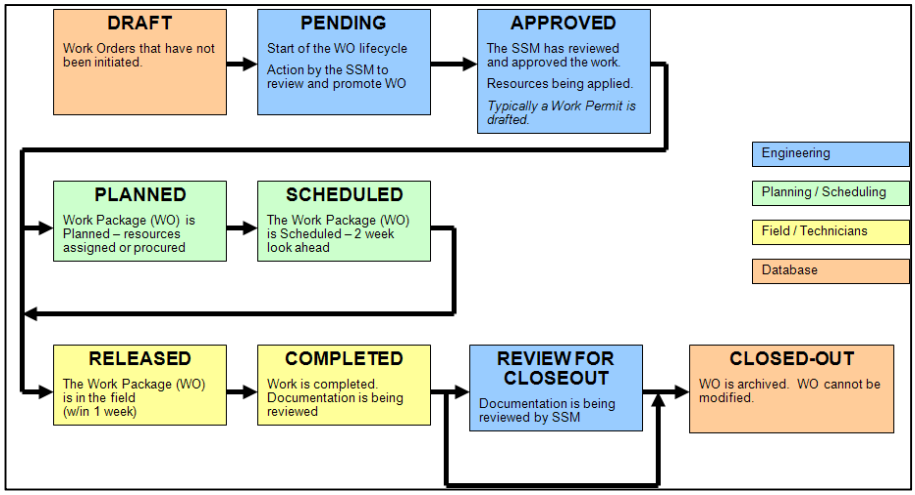
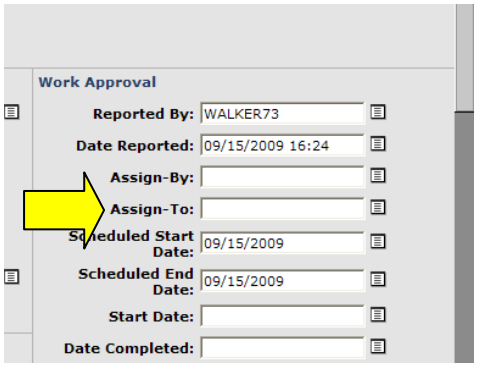


Figure 8. Work Order Progression

8.4.3.4 Assign By

This field is typically the Subsystem Manager. If the Equipment Number is chosen, the Assign By field will be set to equal the subsystem manager listed in the Unified System Hierarchy[5] for that Equipment Number.

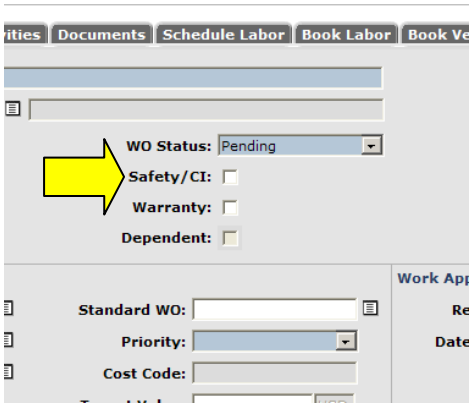
The Assign By can also be manually entered by the user. However, to ensure all work on the subsystem is reviewed by the Subsystem Manager, the following rule will be invoked by SMaRT. If the Assign By entry is not the Subsystem Manager listed in the Unified System Hierarchy, then the "Review For Closeout" field will be automatically set to YES and the Work Order when completed will be routed to the Subsystem Manager listed in the USH.



8.4.3.5 Assign To

This field is typically the Field Supervisor for the group intended to perform the work. If the Equipment Number is chosen, the "Assign To" field will be automatically set.

8.4.3.6 Safety/CI flag



This flag shall only be checked if the Work Order is directing work to be performed on a CI. This field can either be manually set by the user or automatically set by SMaRT.

Users should select this flag if the Work Order will direct work to be performed on a CI.

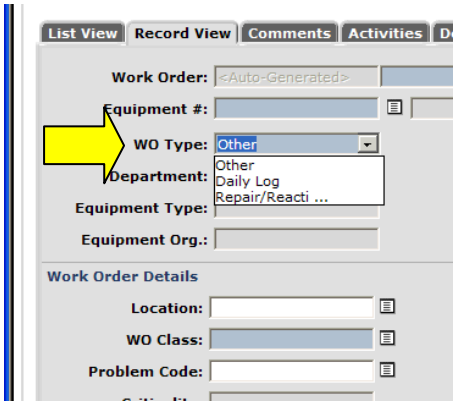
SMART may automatically check the flag. This occurs if the Equipment has been previously designated as a CI in the hierarchy.

In both instances, this box is intended to aid the Subsystem Manager and the Field in identifying CIs. It DOES NOT indicate whether the work performed affects the functionality of the Configuration Item or Configured System. That function can only be performed by the subsystem manager in consultation with the Configured System Manager. Refer to Section 6.6 for further clarification.

8.4.3.7 Work Order Type

The Work Order Type allows a Work Order to be characterized for future reporting or binning for metrics. Work Order Types support the following:

- Goals/Metrics leveraging Work Order Types (refer to Section 2.4 and Appendix K) such as:
    - 4 to 1 ratio of PM to RM work (based on effort hours).
- Management Objectives such as:
    - Articulate the impact of "Other" work on the maintenance work effort.
    - Identify Calibration Work Orders for management reports.



WO Type are viewed on the Work Order Record screen. When a user opens a SMaRT Work Order, the user is given the choice of WO Type (see figure). If the "Equipment #" has not been selected by the user, then the selectable WO Types are: Other, Daily Log, Calibration, and Repair/Reactive.

Furthermore, maintenance in the form of Preventive Maintenance tasks are assigned the WO Type during the setup of the PM Schedule. In this case, the WO Type is pre-set to Preventive Maintenance.

Therefore, the possible selections of WO Type and the general usage for each are:

- Repair/Reactive—unplanned or planned equipment repair (e.g. Replace bearing on compressor #2).
- Preventive Maintenance—planned maintenance tasks designed to prevent failures.
- Calibration—calibration of instruments (assets).
- Daily Log—tasks specifically for taking logs.

- Other—predictive maintenance, projects, commissioning work, all other work that does not fall into one of the other WO Types (e.g. install whiteboard in Strategy Room).

8.4.4 SMaRT Class and Categories

8.4.4.1 Class

The primary function of the Class field determines the type of attributes to be collected into the database for all Positions and Assets. This allows for the communication of desired data to be collected and enables the creation of specific loader sheets for each Class to capture the desired attributes. The collection of these attributes into all positions and assets is intended to provide to the SMaRT User the information required to easily locate and identify the asset to be worked on. The attributes are not intended to drive the procurement/inventory processes.

The secondary function of the Class field is a basis for reporting. In combination with other fields (e.g. Category or System), alternative reports can be generated.

The Class field has been defined with an initial load of approximately 10 types which is loosely based on the traditional engineering disciplines (see table).

Table 11. Sample Classes

Classes in SMART (example)	
BLD	EQP-MECH
EQP-BP	EQP-OPTC
EQP-ELEC	PIPING
EQP-IC	EQP-TOOL
LIFTING	MISC

Each Class also has specific attributes. These attributes are automatically associated to the Equipment Object when assigned to that Class.

Refer to the *SMART Application Guide*[27] for a complete list of Classes, summary descriptions, and associated attributes.

8.4.4.2 Category

A Category provides further definition within the Class. Categories are typically used to group similar equipment based on function, type, etc for reporting. However, the primary function of the Category field in SMaRT is being reserved until more subsystems are added to the SMaRT database.

8.4.5 Processing of Deferred and Overdue Maintenance

8.4.5.1 Deferred Maintenance

Maintenance work may be considered “Deferred”. Deferred maintenance adds to the backlog of maintenance and repairs, but is not included in the backlog calculations. Deferred maintenance is characterized in SMaRT as Work Orders that are either:

- SMaRT Status = Any
- SMaRT Checkbox on Work Order: “Deferred = Y”

8.4.5.2 Overdue Maintenance

Maintenance work may be considered “Overdue”.

In SMaRT, the Scheduled End date is initially set to the PM Due Date when the Work Order is generated. However, the Scheduled End date may be adjusted for work planning, but the PM Due Date will not change. For PM Work Orders, it is possible to use either the Scheduled End Date or the PM Due date. For Reactive Work Orders, only the Scheduled End date can be used because a PM Due

Date would not exist. To ensure consistency in reporting, the Scheduled End date is used for consistency in determining Overdue Maintenance.

Overdue maintenance is defined in SMaRT as: Scheduled End date $\leq$ Today's date.

9 SHIFT TURNOVERS

Refer to the *NIF Operations Management Plan*,[1] Section 7.3, for general policy regarding Shift Turnover. Furthermore, this section provides additional guidance for maintenance organizations.

9.1 Shift Schedules

The Field Manager maintains a shift and vacation schedule. The schedule covers NIF O&M staffed shifts. The schedule is generally prepared two months in advance and will be posted on the Maintenance Strategy Board. Vacation requests should be submitted no less than two weeks before the vacation is to be taken. Any changes to the schedule are coordinated through and approved by the Field Managers. Personnel that cannot make a scheduled shift shall call the Field Supervisor within an hour of their scheduled start time, and let them know that they will be absent and when they expect to return to work. The Field Supervisor will make appropriate adjustments to the schedule. It is not sufficient for the employee to leave a voicemail with the Field Supervisor; an actual conversation between the employee and the Field Supervisor must occur. Should the Field Supervisor be unavailable, it is the employee's responsibility to continue to call until contact is made. Field Supervisors unable to make a scheduled shift shall call the corresponding Field Supervisor (or Field Manager if no other Field Supervisor is available) and notify them of their absence and when they expect to return to work.

9.2 Shift Turnover

Due to the complexity of the facility and the variety of activities that may be in progress, multiple-shift operations present a challenge to the transfer of required information. It is imperative that information concerning the status of equipment, safety concerns, planned operations, and personnel and equipment issues are communicated to the proper personnel. A formal turnover process helps to ensure that this communication is effective.

Shift Turnover is conducted by the out-going Field Supervisor. This brief includes at a minimum: "Open" Work Order Status, facility status, and problems experienced during the previous shift. This turnover activity is used to ensure all personnel are briefed before performing their duties.

Most NIF equipment status/data is available electronically through the control systems or administrative web applications (such as LoCoS and SMaRT). Therefore, the use of turnover checklists is limited and left up to the discretion of the Field Manager.

The out-going shift prepares the status information for review by the on-coming shift. The on-coming shift then reviews the information, resolves any questions, and participates in the briefing of the planned activities for their shift.

When two consecutive shifts will not be able to conduct a direct turnover (i.e., over holidays or weekends), the out-going shift completes turnover checklists and leaves them readily available for the next shift. The O&M summary email can also be used to provide additional information to the next shift. On weekends, due to maintenance, IT Infrastructure, such as network services and applications, may not be fully usable.

9.2.1 Off-Going Shift Responsibilities

For each open Work Order, the DWTLs shall:

- Obtain a copy of the Shift Turnover Checklist at the start of the shift.
- Fill out the header information (names, shift date/time, etc.).
- Transfer any applicable items noted on the turnover from the previous shift in the appropriate section of the checklist.
- Enter any necessary SMaRT Work Orders and LoCoS logs (Problem Reports, Ops Logs, etc.) throughout the shift; note items of particular interest to on-coming shifts on the appropriate section of the turnover checklist. In particular, note any safety items or off-normal operating conditions.
- Near the end of the shift, update the turnover checklist with any status changes.
- Ensure documents for maintenance activities in progress (Procedures, etc.) are complete through the current step and provide them to the Out-going Field Supervisor to transfer to the on-coming Field Supervisor as part of the relief process. Specifically review the status of procedures in progress, including the next required steps and ensure the on-coming operator is aware of the system status.

The Field Supervisor should:

- Obtain a copy of the Shift Turnover Checklist at the start of the shift.
- Fill out the header information (names, shift date/time, etc.).
- Transfer any applicable items noted on the turnover from the previous shift in the appropriate section of the checklist.
- Note items of particular interest to on-coming shifts on the appropriate section of the turnover checklist. In particular, note any safety items or off-normal operating conditions.
- Near the end of the shift, update the turnover checklist with any status changes.

9.2.2 On-Coming Shift Responsibilities

Prior to relieving the out-going shift, the on-coming Field Supervisor should review pertinent logged information (e.g., Shot Ops email, LoCoS Problem Logs, etc.) as specified in the Turnover Checklists.

When appropriate and facility conditions permit, conduct a physical walkdown of the operating equipment, noting conditions.

When relieving the out-going shift, the on-coming Field Supervisor reviews the checklist prepared by the out-going Field Supervisor, and shall obtain clarification as needed. The Field Supervisor will distribute the Work Turnover Packages containing the Work Order and Shift Turn Over Checklist to the appropriate DWTL.

The DWTL and Field Supervisor shall review all applicable documents for work in progress and make particular work stoppage points. They shall obtain clarification from the out-going Field Supervisor as needed.

The on-coming Field Supervisor should submit the turnover NIF Complex checklists, received from the out-going Field Supervisor, to the Field Manager.

10 REQUIRED READING

LLNL's safety policies and procedures are documented in a variety of forms, including but not limited to, the *ES&H Manual*,[29] Facility Safety Procedures (FSPs), Integrated Work Sheets (IWS), Operational Safety Plans (OSPs), subsystem-level maintenance plans, procedures, and checklists. Workers should be familiar with the details in these documents. This section describes the content for required reading and the method for dissemination to the workers.

10.1 New and Recurring Documentation

A binder shall be maintained by the Field Managers for viewing by workers performing maintenance. This binder shall be organized into sections for all hands and for each subsystem. See Table 12 for the types of documents that are required reading. As an example, current minutes from the weekly safety meetings, recent lessons learned, and change synopsis for site-wide documentation (i.e., OSP 581.11,[30] NIF Documents, and various procedures) will be placed in the all-hands section. Each section or document should have a review list attached for personnel to indicate reviews, as appropriate. The Field Manager will make the determination regarding which workers will be required to review the material. Material may be removed after all specified personnel have completed their review or when the material is no longer applicable.

Table 12. Minimum Required Reading

Minimum Required Reading		
Document	**Application**	**Documentation of completion**
Weekly safety meetings minutes/presentations	Required if the worker did not attend the meeting such as workers on another shift	Worker signs the attendance list
Updates to site-wide documentation	e.g., OSP 581.11,[30] IWS, NIF project procedures, ES&H Manual updates	Worker's signature
Lessons learned	All workers will review lessons learned affecting the CF/BUS work teams For all other Lessons Learned, the Field Manager will determine the list of workers to review the documents	Worker's signature
Technical Documents	All workers qualified to work on the system will review updates to the System Level Maintenance Plans	Worker's signature

This binder should be reviewed periodically as determined by the COM Manager and NIF Integration Manager to ensure personnel are staying current with changes to the facility and operations.

10.2 Technical Documentation

The Subsystem Managers working with the Field Managers will develop required reading lists for the affected subsystems which are included in the required reading section of the Qualification Card. Completion of the Qualification Card indicates completion of the required reading.

11 EQUIPMENT AND PIPING LABELING

11.1 Introduction

A well-established and maintained equipment-labeling program should ensure that facility personnel are able to positively identify equipment they operate. In addition, equipment labeling is required by Operational Safety and Health Administration (OSHA) regulations. A good labeling program understood and maintained by operating and maintenance personnel will enhance training effectiveness and will help reduce operator and maintenance errors resulting from incorrect identification of equipment.

The Subsystem Manager shall review systems containing CI items and develop a list of items requiring labeling in accordance with this plan. For all other systems, the responsible Subsystem Manager should incorporate the list as soon as practical.

Refer to Appendix E for specific guidance on implementation including a list of components requiring labeling.

12 CONTROLLING SYSTEMS AND EQUIPMENT STATUS

12.1 Operating Procedures for Equipment and Systems

To prepare, review, approve, control, distribute, revise, and use NIF Operations procedures for operations and maintenance refer to the following documents:

- NIF Procedure 5.14, *Preparation, Content, and Distribution of Operations Procedures*.[23]
- *The NIF Management Procedures: Index and Writer's Guide*.[24]

12.2 Operational Limits Compliance

Facility operating limits may be established for CI equipment and shall be documented in the CI list.

For the NIF, workers are informed of operating limits though the Operating Logs and Operating Procedures. See Section 5.8.1 of this Maintenance Plan for information on Operating Logs.

12.3 Equipment Deficiency Identification and Documentation

All equipment deficiencies shall be immediately reported to the Field Supervisor and/or Field Manager. Deficiencies should then be communicated to the personnel who are responsible for operating and repairing the equipment. This is performed by the Field Supervisor/Manager who will contact the following in order: (1) the Work Control Office, (2) the Systems Manager, (3) the Facility Duty Officer, until notification has been made. If no one is available, then use the Incident Notification procedure.

Equipment deficiencies will be documented using a Problem Log.

Hazardous and concealed conditions that post imminent or serious damage shall be immediately identified and/or fixed or mitigated.

13 POST MAINTENANCE TESTING

Facility equipment on the CI list shall be tested following maintenance to demonstrate that it is capable of performing its intended function. The testing should include all performance functions that may have been affected by the maintenance.

The Subsystem Manager is responsible for writing the post-maintenance test procedures.

The requirement to perform a post-maintenance test shall be indicated on the LoCoS Work Permit. LoCoS provides a field on the Work Permit denoted as "Retest." The subordinate fields should be filled out by the Work Permit Responsible Individual (WPRI) prior to the work being performed.

To ensure that a retest is performed for Preventive Maintenance or Reactive Maintenance work on CI items, SMaRT will automatically fill in the "Retest" field on the SMART Work Order with "Yes." If checked "Yes," a post-maintenance test procedure shall be included as part of the Work Order.

The results of the post-maintenance procedure shall be documented on the Work Order. Subsequent to completion of the Work Order, Planning & Scheduling will confirm that the testing has been documented. As with all Work Orders pertaining to CI Items, the completed Work Order shall then be routed to the Subsystem Manager for review as part of the Work Order Close-out procedure (refer to Section 5.3.4).

14 INDEPENDENT VERIFICATION

This section is applicable to configuration items only.

Equipment on the CI list with manually operated valves, switches, circuit breakers, etc., that do not have alarms or other means of detecting improper positioning are required to be visually checked periodically to ensure that the component is in the required position. This ensures that the system or component functions as required when needed. These periodic reviews, or second checks, shall be conducted at a periodicity commensurate with the probability that the component may be mispositioned, for example after maintenance or after other significant activity in the area of the component.

Components (e.g., valves, gauges, switches, and instrument set points) should be clearly marked to show acceptable position or reading, or specific written documentation indicating acceptable positioning or reading should exist and be available to the individual conducting the independent verification.

The CI Lists are maintained separately from this document, and periodic position verifications requirements are noted there. These checks are tracked and recorded in SMaRT.

The sub-system manager will ensure that the procedure denotes an appropriate method to check process parameters to eliminate the potential for misleading results.

14.1 Independent Verification after Maintenance

After the equipment or system has been returned to service following maintenance, put in a bypass mode, or tested for proper functioning, independent verification shall be conducted and documented. The independent verification should be performed by another worker not directly involved in the maintenance activity. The effort should be made to ensure the worker performing the independent verification is not directly involved in the maintenance work performed.

14.2 Periodic Independent Verification

Periodic independent verification checks should be performed during normal facility operations. The Subsystem Manager should request that this verification be performed as appropriate for position verifications noted in the Configuration Items Lists. The independent verification will be documented on a SMaRT Work Order and performed by the worker assigned by the Field Manager.

15 OPERATIONS ASPECTS OF FACILITY CHEMISTRY AND UNIQUE PROCESSES

The important operating parameters of a facility or an experimental setup are monitored continuously and directly via gauges, meters, or other instrumentation. This section applies to those parameters that cannot be monitored directly and for which samples must be taken and analyzed to determine their status.

After evaluation, the NIF at this time does not contain parameters which require samples to be taken and analyzed to determine the status. NIF Site Integration, together with the Facility Management and/or NIF Operations management, shall reassess the requirement as CIs are identified and before bringing those items requiring sampling into the NIF.

16 RESETTING PROTECTIVE DEVICES

Unless documented in an approved procedure, prior to resetting protective devices (breakers, fuses, etc), the Subsystem Manager (SSM) should be notified and an attempt should be made to understand the cause of the trip before the device is reset. If the device trips/fails a second time, immediately stop and contact the SSM to conduct a more detailed analysis. If a third attempt to reset the device is desired, the appropriate COM Manager shall also be consulted. A Problem Log should also be generated.

17 LEVELS OF OPERATION (BUS/CF ONLY)

Levels of Operation are criteria used to define the work that may be performed during a shift. Levels of Operation are determined primarily by whether the Field Supervisor or DWTL is present onsite. Level 3 is the initial operating level. The conditions outlined below must be met to operate at Levels 1 or 2.

Level 1—all work under an approved Work Permit may proceed provided the following conditions are met:

- A Field Supervisor (BUS or CF) must be present.
- If a Field Supervisor is absent, then:
    - For instance, if the BUS Field Supervisor is absent, the CF Field Supervisor will review each work permit with BUS DWTL. The CF Field Supervisor will make a determination on whether work may proceed.
    - For instance, if the CF Field Supervisor is absent, the BUS Field Supervisor will review each work permit with CF DWTL. The BUS Field Supervisor will make a determination on whether work may proceed.
    - Each permit will be reviewed individually.
    - DWTL must be present for work to proceed.
- If a DWTL is absent, then:

- For instance, if the BUS DWTL is absent, the BUS Field Supervisor may act as the DWTL for one work front (i.e., a single Work Permit).
- For instance, if the CF DWTL is absent, the CF Field Supervisor may act as the DWTL for one work front (i.e., a single Work Permit).

Level 2—No maintenance or commissioning work may proceed. No beampath maintenance or commissioning work is authorized. However, system monitoring functions may proceed such as walking down systems and recording readings if the following condition is met:

- Level 2 is enacted if no Field Supervisors (BUS or CF) are present but DWTLs are present.

Level 3—No work may proceed. Work crews will remain in Diagnostic Bldg until directed otherwise. A worker shall contact the BUS O&M Manager, CF O&M Manager, or Facility Duty Officer for further direction.

- Level 3 occurs when no Field Supervisors or DWTLs (BUS or CF) are present.
- Level 3 is the default Operating Level.

18 CALIBRATION PLAN (CF/BUS ONLY)

This section applies to equipment in the Conventional Facility or Beampath Utilities systems. Calibration of Laser Hardware is maintained elsewhere and will be described in a future version of this maintenance plan.

This Section of the Maintenance Plan is NIF's Calibration Plan, which ensures that measuring and test equipment (M&TE) is in an optimum state of readiness. Furthermore, NIF's Calibration Plan is in line with the *NIF &PS Calibration Plan*[31] and works to ensure compliance to all requirements set forth in the ES&H manual, VOL IV.

The M&TE Coordinator interfaces with Subsystem Managers to perform this function and utilizes SMaRT to schedule, track, and maintain history of all calibrations performed. NIF has identified three calibration approaches, which are referenced throughout this section to delineate describe the specific approaches being applied:

- IN SITU—Calibrations performed on M&TE installed as part of a subsystem.
- OUTSOURCED—Calibrations on M&TE removed from a subsystem and performed by outsource vendors.
- IN HOUSE—Calibrations performed on M&TE at the NIF calibration laboratory capable of providing NIST traceable calibrations.

The following procedures provide detailed instructions for the execution of the Plan:

- *In-Situ Calibration* (NIF-5021061).[32]
- *Outsourced Calibration* (NIF-5021062).[33]
- *In-House Calibration* (NIF-5021063).[34]
- *Calibration Out of Tolerance Notification* (NIF-5021064).[35]
- *M&TE Handling and Storage* (NIF-5021065).[36]
- *Procurement of Calibration Services* (NIF-5021067).[37]
- *Calibration Reports/Metrics* (NIF-5021068).[38]

Measuring and Test Equipment (M&TE) equipment that is installed in a subsystem will be included in equipment hierarchy and remain the responsibility of the SSM (e.g., pressure transmitter). Other M&TE equipment that is not a part of the subsystem may be used to perform work on these systems (e.g., torque wrenches, meters, etc.) and is the responsibility of the M&TE Coordinator. The responsibilities of the M&TE Coordinator include:

- Ensuring that all units in inventory are calibrated (in situ or off line) to applicable standards and ready for use.
- Retaining records for each numbered M&TE in SMaRT.
- Generating reports and metrics to manage the recall of M&TE requiring calibration.
- Ensuring all vendors used for procured services meet the requirements set forth in the NIF Procedure 7.4.[39]

The SSM assigns a unique identifier to each M&TE asset and the asset will be labeled or marked with the unique identifier. The Subsystem Manager, working with the M&TE Coordinator, will establish intervals for preventive maintenance, calibrations/verifications, and intermediate checks based on manufacturer's instructions or on past experience with similar equipment. The intervals of these activities are stored in SMaRT as a PM Schedule, which then generates Work Orders.

The M&TE Coordinator will generate a "Cal Due" report from SMaRT on a monthly basis to recall devices requiring calibration or verification. A copy of the "Cal Due" report will be transmitted to each SSM.

Section 20.2 and 20.3 describe, in detail, how the M&TE Coordinator and maintenance organization interact.

18.1 MT&E Installed as System Part

In the case of M&TE that can be calibrated in place while installed within a subsystem (in situ), calibration will be performed in accordance with the *In-situ Calibration Procedure* (NIF-5021061).[32]

A Work Order is generated from SMaRT to perform the calibration and route it to the appropriate SSM. Details on performing the calibration will be included in the calibration procedure attached to the work order.

In the case of M&TE that cannot be calibrated while installed in a subsystem (in situ), the equipment will be removed from service and returned to the M&TE Coordinator for calibration in accordance with the *Outsourced Calibration Procedure* (NIF-5021062).[33]

A Work Order will be generated in SMaRT to remove the device from its installed location following a procedure provided by the SSM. This Work Order will include instructions for the following process.

18.2 Measuring and Test Equipment (M&TE) Not Installed as System Part

In the case of M&TE not installed in a system (e.g., torque wrenches, meters, etc), or M&TE used as transfer standards, calibration will be performed in accordance with the *Outsourced Calibration Procedure* (NIF-5021062).[33]

The M&TE Coordinator will recall devices requiring calibration or verification. A copy of the "Cal Due" report generated by SMaRT will be transmitted to the user/assignee, requesting that the equipment is returned to the Inventory Control Clerk who will make the asset available to the M&TE

Coordinator. If available the Inventory Control Clerk will provide a replacement device to the user/assignee.

18.3 Calibration Facility

A calibration facility has been established in B581 R3006 that serves as the focal point for performing calibration of M&TE that can be performed in house yet not installed in a subsystem (e.g. particle counters), per the *In-house Calibration Procedure* (NIF-5021063).[34] The facility is maintained at the same environmental conditions as that in which the M&TE resides during normal use. The facility is also used as the primary storage location of all documentation (e.g., calibration certificates, data sheets, and calibration records) regarding calibration.

19 MODIFICATION WORK

19.1 Interface to NIF Operations Support

The Maintenance group interfaces to the Operations Support through generally accepted practice. The details of the interface are contained in this section.

It is the responsibility of the Subsystem Manager to maintain the configuration of the installed system. Therefore, the Subsystem Manager is the primary interface point for any work that has the potential to affect the installed system.

The Subsystem Manager may request support when one or more of the following exists (but not limited to):

- Maintenance actions are not sufficient to completely restore the system to service.
- System component replacement in which reliability and maintainability are increased but performance criteria is impacted.
- The Subsystem Manager determines that improvements to or modernization of the system is required to maintain the system's functionality.
- The Subsystem Manager is requested to modify the system for added functionality.
- The System's requirements, as documented in RMS, change.

In each of these cases, the Subsystem Manager submits a project request through the Request Line. The Request Line creates a Work Order, which will contain the initial requirements for the project with the Subsystem Manager acting as the Project's customer. The Work Order Type will be designated "Active Project" and the Work Order Class will reflect if the project consists of engineering, construction, or engineering and construction. The Work Order will then be routed through the regular NIF Operations project delivery process, specifying the documented requirements of the project.

During the planning phase of the project, the Subsystem Manager shall:

- Establish the system performance requirements for the affected system.
- Establish the scope of work and deliverables expected from NIF Ops Support (Engineering and Construction).
- Develop the schedule requirements for completion of the work through interaction with NIF Ops Support
- Communicate the budget constraints for the work to be performed by NIF Ops support.

- Act as the Client and single point of contact for the project work to be performed by NIF Ops Support.
- Ensure that an ECR is opened for documentation changes.

During the design phase of the project, the Subsystem Manager shall:

- Assist NIF Ops Support in the development of a Basis For Design (BFD) for the project and approve BFD prior to initiation of design.
- Act as the Client and single point of contact for the project work to be performed by NIF Ops Support.
- Represent the current system operating conditions and limitations to the design team.
- Participate in design reviews.
- Participate as a final reviewer and approve final design prior to construction start.

During the construction phase of the project, the Subsystem Manager shall:

- Act as the Client and single point of contact for the project work to be performed by NIF Ops Support.
- Be included as an Affected RI on all Work Permits for work on the system.
- Participate in progress reviews.
- Perform a final walkdown of the system and generate punch list for construction completion.
- Begin development of commissioning test plan with interaction from NIF Ops Support.
- Participate with NIF Ops Support personnel during startup and checkout system testing.
- Review work at construction completion for final acceptance thereby accept system ownership.

Upon acceptance (IQ completed), the Subsystem Manager shall:

- Ensure the successful completion of the “OQ” process including:
    - Lead the re-commissioning of the system, as required.
    - Receive Operation and Maintenance Procedures from the manufacturer.
- Review changes to documents under Configuration Management.
    - ECR has been completed.
    - Equipment As-built drawings are in ECMS.
- Ensure the successful completion of the “MQ” process as follows (also refer to Section 20.1):
    - Maintenance procedures are loaded in ECMS and attached to PM tasks in SMaRT.
    - The SLMP has been written or updated.
    - Update the System Technical hierarchy, as required.

- Ensure the system level maintenance plan is revised, as necessary.
- Load relevant maintenance documents into ECMS.

During the execution of the project the NIF Ops Support group shall:

- Provide construction cost and schedule estimates to support the project authorization process.
- Develop a project control plan that includes a detailed project schedule and cost estimate.
- Provide a budget/cost status report throughout the life of the project.
- Coordinate work execution through work control office.
- Manage all sub-contractors and coordinate installation activities.
- Provide all as-built documentation, O&M Manuals and warranties to the Subsystem Manager.
- Complete all punch list items before final acceptance.
- Designate a Project Manager or Lead Engineer, depending on the scope of the project, to act as a single interface to the Subsystem Manager.

19.2 Placement into the Maintenance Program (the MQ process)

Newly constructed or installed equipment should be inspected and readied for operations according to several accepted processes known as Initial Qualification (IQ), Operational Qualification (OQ), and Performance Qualification (PQ). NIF is establishing the Maintenance Qualification (MQ) process.

The following must be completed before the Maintenance Qualification (MQ) milestone is achieved:

- System Level Maintenance Plan is released in ECMS, including:
  - FMEA updated.
  - Safety Notes compiled and re-reviewed.
  - Drawings identified.
  - Operating Log requirements identified.
  - Emergency response procedures listed.
- Preventive Maintenance procedures released in ECMS.
- Subsystem equipment listed in a hierarchy and loaded in SMaRT.
- PM Schedules established and loaded in SMaRT.
- Necessary drawings corrected to as-built.
- Spare parts identified (does not include obtaining N#s).
- Operating procedures written and released in ECMS.
- Qual Cards written, validated, and loaded in ECMS.
- Service contracts (by outside vendors) identified.

However, due to the varying types of construction and installation projects, the specific requirements for the MQ process should be tailored to the specific installation or constructed equipment.

20 ENVIRONMENTAL MANAGEMENT

This section provides the approach to Environmental Management for the NIF. Refer to NIF Procedure 1.08, *Environmental Management*,[40] for flowdown protocols and requirements for the environmental programs pertaining to NIF.

20.1 Storm Water Pollution Prevention Plans

The NIF Programs Directorate ES&H organization is responsible for establishing and administering the SWPPP program.

The NIF Conventional Facilities O&M group maintains staff to execute the specific NIF SWPPP measures and regularly reports on actions taken to the NIF Programs Directorate ES&H organization.

20.2 Sanitary Sewer

The NIF Operations Maintenance Manager has assigned the responsibility for managing the Sanitary Sewers to the Sanitary Sewer Subsystem Manager. The Sanitary Sewer Subsystem Maintenance Plan contains the approach and plans to meet the requirements of NIF Procedure 1.08, *Environmental Management*.[40]

20.3 Standby Generators (Internal Combustion Engine)

The NIF Operations Maintenance Manager has assigned the responsibility for managing the Standby Generators to the Electrical Utility Systems Subsystem Manager. The Electrical Utility Subsystem Maintenance Plan contains the approach and plans and permits to meet the requirements of NIF Procedure 1.08, *Environmental Management*.[40]

20.4 Boilers

The NIF Operations Maintenance Manager has assigned the responsibility for managing the Hot Water Boilers to the Hot Water Systems Subsystem Manager. The Hot Water Subsystem Maintenance Plan contains the approach and plans and permits to meet the requirements of NIF Procedure 1.08, *Environmental Management.*[40]

20.4.1 BAAQMD Permits to Operate (PTOs)

- Refer to NIF Procedure 1.08, *Environmental Management*,[40] for a list of permits.
- Refer to this procedure when:
    - There is an air permit custodian change.
    - There is a need to change the air permit.

20.4.2 Wipe Cleaning

Use of volatile solvents will be minimized to the extent practical. For wipe cleaning using solvents (i.e., acetone, ethanol, isopropyl alcohol and methanol) refer to NIF Procedure 1.08, *Environmental Management*.[40]

21 SEASONAL/SEVERE WEATHER AND ADVERSE ENVIRONMENTAL MAINTENANCE

21.1 Facility Preservation During Severe Weather Plan

Plans should be developed, implemented, and documented to prevent equipment and building damage at NIF, because of the potential for severe seasonal and environmental conditions as follows:

- Cold Weather.
- Strong Winds.

Buildings and equipment with the potential for damage from seasonal weather conditions should be identified, and a risk assessment based on the graded approach should be conducted. The plan should include contingencies for the critical facilities or equipment that are likely to sustain damage when severe conditions are expected. The plan should ensure that, in all cases, the preparatory actions and requirements imposed to provide severe conditions protection, particularly those taken to restrict safety system functions, be reviewed by facility operations and safety personnel before implementation to ensure that the facility is maintained in a safe condition to protect the health and safety of the public. As a minimum, this plan should address the following:

- A checklist for facility management to ensure the implementation of actions to provide protection for their assigned areas of responsibility before severe conditions.
- Identification of items requiring major modifications or redesign to mitigate/prevent equipment damage. For items that may not be changed before the upcoming severe condition, interim actions should be taken to prevent equipment damage.
- Specific responsibilities for the operations staff and building managers for monitoring the temperatures in facilities on and off shifts, including weekends and holidays.
- Provisions for alerting personnel and providing increased surveillance in periods of extreme, unusual, or extended severe conditions.
- Adequate gear, tools, and equipment are available for use for emergency and operations personnel.
- The recalibration of exposed instrument loops when instrument lines or transmitters are subjected to severe conditions.
- A review of the status of safety-related equipment during severe conditions and assurance that inoperable equipment is available for return to service, if possible.
- A review of surveillance schedules and considerations given to performing surveillances early, if possible, or delaying them until after the severe condition passes, if permitted, to minimize equipment out of service.
- Inspection of outside areas for loose materials and debris, which may become missiles in a strong wind, and securing to the maximum extent possible.
- The availability of adequate lumber and other supplies for wind protection or damage control.
- Verification of operability and availability of communications equipment.
- Identification of plant vehicles needed for emergency use and ensure vehicles have a full tank of fuel and are in good repair.
- The availability of equipment for making emergency repairs.

- Ensuring materials susceptible to severe conditions damage are properly stored and protected.
- Ensuring the protection of accumulation site waste containers and bulk chemicals from potential damage as a result of seasonal hazards.
- Ensuring all building doors and windows can be properly secured.
- Provisions to remove seasonal weather protection features after the weather season is over, with appropriate verification and documentation of return to normal service through the facilities configuration management system.

21.2 Cold Weather Planning

In addition to the list of items listed in Section 21.1, the following should be included to minimize equipment and building damage from cold weather conditions, temperatures less than or equal to 35º F, including hail, snow, and ice.

- Identifying areas where portable heating may be required and obtaining portable heating equipment, approved by the fire protection engineering group.
- Monitoring the conditions surrounding fire protection sprinkler systems to ensure a temperature of above 40º F is maintained.
- Ensuring air intakes, windows, doors and any other access points that may result in abnormal flow of cold air into an area susceptible to freeze damage are secured.
- Ensuring heating systems are cleaned, serviced, and functionally tested.
- Ensuring antifreeze used in cooling systems is checked and replaced as necessary.
- Ensuring heating system power and temperature controls are protected against inadvertent deactivation.
- Ensuring systems requiring or deserving special protection due to hazards or costs associated with freeze damage have temperature alarms and/or automatic backup heat sources.
- Inspecting, testing, and staging portable auxiliary heaters and identifying sources to obtain more, if needed.
- Training personnel in the safe use of portable heaters.
- Ensuring the main water supply cutoffs for each critical facility are identified, tested, and readily accessible to emergency personnel responding to a freeze/thaw incident.
- Inspecting outside storage pads and unheated storage areas to ensure that there are no materials susceptible to freeze damage.
- Implementing snow and ice removal activities.
- Ensuring employees are aware of the need to identify and report any suspected problem with heating or other cold weather protection equipment (e.g., noninsulated water or process pipes, steam trace heaters valved off, electrical trace heaters turned off or burned out, broken windows, holes in exterior walls).
- Evaluating the removal of freeze protection equipment from service during the seasonal freeze period.

- Reviewing wet-pipe sprinkler systems for areas susceptible to freezing and taking appropriate actions such as making provisions for auxiliary heat, draining, and/or posting a fire watch.
- Ensuring availability and use of salt, sand, and “ice-chaser” as needed.
- Inspecting outside areas to ensure that gutters and downspouts are provided where there is a potential for ice buildup that may restrict egress.

21.3 Hot Weather Planning

In addition to the guidelines listed in Section 21.1, the following should be included to minimize equipment and building damage from extreme hot/dry weather.

- Plan for the safe shutdown of vulnerable equipment.
- Restrict operations which involve heat (welding, burning, sparks, etc.).
- Restrict fire hazards (smoking, etc.).
- Ensure an ample supply of portable fire extinguishers are available.
- Ensure fire protection personnel are alerted.
- Ensure all exits are kept clear.

22 REVISION LOG

Version	Description of Change	Date of Issue
AH	Updated Section 4.7 to satisfy Readiness Assessment requirements	March, 2011
AG	All Sections – revisions to section numbering to closer align with DOE G 433.1-1. Sections 2, 3, 4, 5, 6, 7, 8 – content added, rearranged, or substantially revised. Appendix A, B, D,E,K,L – added or deleted content.	October, 2009
AF	Revised Section 4.7 to address current practice and planned future approach using SMaRT	October, 2008
AE	Revised Appendix I. Revised Section 17. Revised Section 23	September, 2008
AD	Added Section 20 - Environmental Management, Section 21 – Supporting Documents, and Section 8.3, Equipment Field Labels. Updated References Updated 5.5.1 with additional requirements for log taking. Revised 20.2 with additional content to achieve MQ . Revised 4.3.2 and 5.4 for Conduct of Ops requirement. Added Appendix J.	August, 2008
AC	Entire Document - Minor typographical corrections. Section 3.3 – updated to accommodate the new Section 18. Section 3.7 deleted and text incorporated into Section 20.1. Section 5.5.1 – added ECMS number for Op Log Template. Revised date for electronic version of logs to 2009. Section 16 – added documents to list. Section 17 – Levels of Operation, entire section added. Section 18 – Calibration Plan, entire section added. Section 19 – entire section added. Section 20 – entire section added. Table 2 – content added. Section 8.2.1 revised for ES&H 3.5 updates. Appendix A – updated. Appendix B - updated	May, 2008
AB	Section 4.8—added and revised content. Section 5.4—added and revised content. Section 9—renamed, added content, and revised existing content. Section 14—added entire section. TOC—updated to reflect section changes. Reorganized sections and made compliant with NIF Writers Guide	February, 2008
AA	New document	August, 2008

23 KEY REFERENCES

The maintenance plan is one of several documents that describe the operation and maintenance of the NIF. The maintenance plan is not all encompassing, and the reader is advised to refer to other documents for information outside the scope of this document. Documents specifically referenced in this Maintenance Plan include:

1. *The NIF Operations Management Pla*n, NIF-5020544
2. *NIF Shot Operations Plan*, NIF-5018506
3. *Maintenance Implementation Plan*, NIF-0114776
4. *Unified System Hierarchy*, NIF-5021086
5. NIF Management Procedure 11.2, *NIF Operations On-Call Field Supervisor Response*, NIF-5018946
6. *NIF Operations Facility Duty Officer Response Procedure*, NIF-5018691
7. *Initiating Work Maintenance Work Flow Process*, NIF-0114377
8. *NIF Operations Maintenance Work Request Procedure*, NIF-0113513
9. *Maintenance Work Order Approval*, NIF-5021297
10. *TESA Lock Work Coordination*, NIF-5021844
11. NIF Procedure 5.5, *NIF Access*, NIF-5022192
12. *Preventive Maintenance Work Order Generation*, NIF-5021296
13. *Maintenance Internal Operations Work Flow Diagram*, NIF-0114615
14. *NIF Operations Maintenance Work Planning and Scheduling*, NIF-0113509
15. *NIF Maintenance Work Order Execution*, NIF-5021295
16. *Maintenance Work Order Closure Work Flow Process*, NIF-0114223
17. *NIF Maintenance Work Order Close Out Procedure*, NIF-5019007
18. NIF Procedure 5.11, *Management Review*, NIF-5026065
19. *NIF Management Procedure 5.8, NIF Work Permits*, NIF-5018626
20. *NIF Configuration Management Plan*, NIF-5018949
21. *NIF Configured Systems and Configured Item List*, NIF-5018525
22. *NIF Operations Maintenance Documentation and Record Filing*, NIF-0114507

23. NIF Procedure 5.14, *Preparation, Content, and Distribution of Operations Procedures*, NIF-5018668

24. NIF Procedure 11.1, *The NIF Management Procedures: Index and Writer's Guide*, NIF-5020542

25. NIF Procedure 6.4, *Control of CM Documents*, NIF-5018532

26. *SMaRT Preventive Maintenance Naming Standards*, NIF-5020248

27. *SMART Application Guide*, NIF-5022655

28. *SMaRT Change Request*, NIF-5021714

29. ES&H Manual, Volume V, Document 52.1, LLNL Maintenance Management Program for Non-Reactor Nuclear Facilities

30. *Operational Safety Procedure 581.11*, NIF-5017295

31. *NIF&PS Calibration Plan*, NIF-0100032

32. *In-Situ Calibration*, NIF-5021061

33. *Outsourced Calibration*, NIF-5021062

34. *In-House Calibration*, NIF-5021063

35. *Calibration of Out of Tolerance Notification*, NIF-5021064

36. *M&TE Handling and Storage*, NIF-5021065

37. *Procurement of Calibration Services*, NIF-5021067

38. *Calibration Reports/Metrics*, NIF-5021068

39. NIF Procedure 7.4, *Procurement Planning, Scheduling, Review, and Approval*, NIF-5018887

40. NIF Procedure 1.08*, Environmental Management*, NIF-0112709 (DOE 5480.19 CH2.C.7)

APPENDIX A: DEFINITIONS

Acoustical/Ultrasonic Testing—A technique used to measure acoustical emissions from components such as valves and heat exchangers. This technique is used to monitor valves for leakage and heat exchangers for proper flow rates. In addition, ultrasonic testing may detect weld crack propagation and check for piping erosion/corrosion effects.

Asset—A basic unit to receive allocated maintenance resources. Examples of assets; buildings / grounds, systems, equipment, software, people.

Asset Management Systems—Processes and/or procedures that are employed for non-programmatic management of a facility or physical asset.

Availability—The time a mission critical SSC, machine, or system is available for use. From the overall SSC/equipment effectiveness calculation, the actual run time of a mission critical SSC/machine or system divided by the scheduled run time.

> **NOTE:** Availability differs slightly from Asset Utilization (Uptime) in that scheduled run time varies between facilities and is changed by factors such as scheduled maintenance actions, logistics, or administrative delays.

Backlog—All maintenance work which has been approved with the required parts on-hand for completion of this work. This represents the magnitude of maintenance work to be done through any given period of time as measured by Work Order dates.

Baseline—A quantitative expression of projected costs, schedule, and technical requirements; the established plan against which the status of resources and the progress of a project can be measured.

Building—A roofed structure that is suitable for housing people, material, or equipment. Also included are sheds and other roofed structures that provide partial protection from the weather.

Calibration—The comparison of readings from the instruments being tested with validated readings observed on the measurement standards.

Capital Spares—Items that are capitalized and depreciated in accounting as opposed to expensed. Capital spares are generally; large, expensive, long order lead and/or obsolete.

Certification—An indication by the appropriate authority that the deviations determined in the calibration do not exceed specified limits.

Check—Perform a comparison with stated requirements. No manipulation of equipment by the checker is involved.

Child—A particular level in a structure or grouping of assets responsible to Parents for ownership. Parent/child relationships are important for rollup of maintenance costs.

Component—A piece of equipment, such as a pump, valve, motor, or instrument that is normally assigned a unique equipment identifier.

Component Failure—Loss of ability of a component to perform one or more of its functions.

Computerized Maintenance History Engineering Database—A set of computer software modules and equipment databases containing facility data with the capability to process the data for facilities maintenance management functions. This set provides historical data, report writing capabilities, job analysis, and more. The data describe equipment, parts, jobs, crafts, costs, step-by-step instructions, and other information involved in the maintenance effort. This information may be stored, viewed, analyzed, reproduced and updated with just a few keystrokes. The maintenance-related functions typically include:

- Maintenance cost and reliability data.
- Facility/equipment inventory.
- Facility/equipment history.
- Work input control.
- Job estimating.
- Work scheduling and tracking.
- Preventive and predictive maintenance.
- Facility inspection and assessment.
- Material management.
- Utilities management.

Computerized Maintenance Management System (CMMS)—A computer software package for the purpose of assisting with maintenance management.

Condition Assessment Survey (CAS)—A periodic inspection of capital assets using universally accepted methods and standards. CAS results in a determination of the current condition of capital assets, their estimated time of failure, and the estimated cost to correct the identified deficiencies. CAS provides a consistent assessment of capital assets for planning purposes based on actual conditions.

Condition Directed Task—A task performed when component performance or condition reaches a limit (either predefined or determined by engineering evaluation) measured by performance or condition monitoring test where continued satisfactory operation cannot be ensured.

Condition Monitoring—Tests and inspections that may be accomplished on an unobtrusive basis to identify a potential failure. Condition monitoring includes established predictive maintenance techniques.

Corrective Action—The action required to bring a deficient item into conformity with a standard. For material deficiencies requiring maintenance action, the corrective action may consist of identifying the deficiencies, submitting a Work Request/Work Order for corrective activities, and tracking the deficiency. Deficiencies should be reported in accordance with applicable policies and procedures.

Corrective (Repair) Maintenance—The repair of failed or malfunctioning equipment, system, or facilities to restore the intended function or design condition. This maintenance does not result in a significant extension of the expected useful life.

Condition Directed (CD)—A maintenance strategy that may or may not involve asset intrusive tasks and is based upon the application of predictive maintenance technologies. Typical asset intrusive maintenance tasks include; removing equipment guards to mount accelerometers and adjusting equipment operational parameters to match prior data collection sets.

Consumables—Items which may or may not be identified in a manufacturer's manual for an asset and are consumed or depleted during asset life cycle. Consumables are not necessarily asset manufacturer and model number specific. Examples of consumables; grease, oil, shim stock, rags, cleaner, paint, etc.

Continuous Improvement—An action step as part of a process that continually incorporates feedback in an effort to drive organizational improvements.

Corrective Maintenance (CM)—Allocated maintenance resources to restore an asset. This form of maintenance is initiated as a result of prior maintenance allocated to the asset(s) that identified needed follow-on maintenance at a later planned date.

Criticality—A pre-determined magnitude of importance based upon criterion within one or more subject areas deemed critical to an organization.

Deferred Maintenance (DM)—Known maintenance work in which a conscious decision is made not to perform. The decision not to perform this maintenance work can be based upon; end of asset life cycle, planned shutdown which would minimize operational impacts, planned project work, etc.

Deferred Maintenance Cost—The cost of Deferred Maintenance. For the purpose of reporting deferred maintenance of DOE real property, deferred maintenance is that cost required to restore a facility to its current use as-built condition. Maintenance cost/work do not include the following:

- Regularly scheduled janitorial work such as cleaning and preserving facilities and equipment.
- Work performed in relocating or installing partitions, office furniture, and other associated activities.
- Work usually associated with the removal, moving, and placement of equipment.
- Work aimed at expanding the capacity of an asset or otherwise upgrading it to serve needs different from or significantly greater than those originally intended.
- Improvement work performed directly by in-house workers or in support of construction contractors accomplishing an improvement.
- Work performed on special projects not directly in support of maintenance or construction.
- Non-maintenance-related roads and grounds work, such as grass cutting and street sweeping.

Deficiency—Any condition that deviates from the designed-in capacity of an SSC and results in a degraded ability to accomplish its intended function.

Deficiency Tag—A small tag that is used to identify a facility material deficiency. The form may be marked with a serialized number for administrative control, Work Order identification, and deficiency location by maintenance personnel.

Effectiveness—The capability of a preventive maintenance task to improve component reliability to a given level under cost, implementation, and other constraints.

Emergency Maintenance (EM)—Maintenance work that requires immediate attention. This type of maintenance is typically associated with environmental, health, safety, danger and/or catastrophic operational impact.

Equipment—The systems and devices used throughout DOE and commonly referred to as equipment are divided into three categories for the purpose of this Order. It is the intent of this definition to separately identify the installed equipment that can logically be considered as an integral part of a real property improvement from other types of equipment. The purpose of such a determination is to provide a uniform basis for analysis of various maintenance and repair costs.

1. Installed Equipment. This category includes the mechanical and electrical systems that are installed as part of basic building construction and are essential to the normal functioning of the facility and its intended use. Examples are heating, ventilating, and air-conditioning (HVAC) systems; elevators; and communications systems.

2. Programmatic Equipment. Equipment (both real and personal) dedicated for a specific programmatic use. Examples are accelerators, microscopes, radiation detection equipment, lasers, and glove boxes.
3. Other Equipment. Some examples in this category are office machines, vehicles and mobile equipment, helicopters, airplanes, and computers and other automated data-processing equipment.

Excess—Physical assets that are not required for DOE needs and the discharge of its responsibilities.**Experienced-Centered Maintenance—**An approach to identify or influence preventive maintenance tasks or plans by leveraging the knowledge of personnel engaged in the operation, maintenance or construction of facility SSCs.

Facility (Facilities)—Land, buildings, and other structures, their functional systems and equipment, and other fixed systems and equipment installed therein, including site development features outside the plant, such as landscaping, roads, walks, and parking areas; outside lighting and communication systems; central utility plants; utilities supply and distribution systems; and other physical plant features. A building, utility, structure, or other land improvement associated with an operation or service and dedicated to a common function

Facility (Facilities) Management—A documented process by which facilities are operated and maintained.

Facility Information Management Systems (FIMS)—DOE's corporate database management system with the universe of DOE real property information, its status, and funds needed and requested for maintenance. FIMS is used for real property management and for reporting to the General Services Administration, Congress, and the public.

Failure—See definition of functional failure.

Failure Cause—The physical mechanisms or reasons that produced the failure.

Failure Data Analysis—Analysis of past component performance, maintenance, and repair histories to predict future availability, recognizing that historical data have predictive value only to the extent that the conditions under which the data were generated remain applicable.

Failure Effects—The consequences of a failure.

Failure Finding (FF)—A maintenance strategy that involves the following; inspections, checks, recording of data, etc. The Failure Finding maintenance strategy is not asset intrusive.

Failure Finding Task—A task performed to discover hidden failures when no other tasks are judged to be applicable and effective in detecting degradation in component performance.

Failure Mode—The particular type or manner of failure. A failure mode describes what may happen, or has happened, as opposed to what caused it to happen. For example, a motor-driven pump fails to run or a circuit breaker fails to open are different kinds of failure modes.

Failure Mode and Effects Analysis (FMEA)—A technique used to determine significant failure modes of critical components by analyzing the effect of the failure on a system or the facility and the likelihood of the failure mode to occur.

Failure Rate—The number of mission critical SSC failures divided by an interval such as time or cycles. The failure will change over time and can be greater than one (but will never be less than zero).

Failure Rate Database— Facility specific or generic historical data on component failures and failure modes extracted from log books, maintenance records, Work Orders or other documents and

computerized so that reliability parameters can be derived. An automated database of specific types of SSC failure rates and performance trends that can be used to scientifically justify appropriate changes to maintenance task/frequency intervals, based on empirical service history and operating experience. An effective preventive maintenance program needs a comprehensive component reliability and failure rate database. The database serves as a scientifically sound basis for compiling maintenance task/frequency intervals for a given type of SSC. Comparisons within the database may serve as a useful inspection tool when using probabilistic risk assessment techniques to identify vulnerable critical areas of SSCs important to safety.

Frequency of Maintenance (FOM)—Time definition of how often time-directed maintenance is to be performed.

Function—The actions or requirements that a component or system should accomplish, sometimes defined in terms of performance capabilities.

Functional Failure—A failure that results in a loss of component or system function(s). The failure may be active or passive, evident or hidden.

General Use Tools—Tools provided to each worker or work team that are used on a regular basis to compete tasks.

Grace Period—A time period after the scheduled completion date in which the activity may be completed without being considered overdue. This time period is normally 25 percent of the scheduled interval.

Gross Error—An out-of-tolerance condition for an instrument in the Measuring and Test Equipment (M&TE) Program which may result in an unacceptable product. When a facility handbook has not been prepared or does not list gross error limits, any condition outside the calibration limits, defined by supervision in the group using the equipment, is considered a gross error.

Housekeeping—The cleaning and preservation of a facility, its systems and components. Also used to refer to the condition of facility cleanliness, orderliness, and preservation.

Independent Verification—Check by one or more knowledgeable individuals not involved in the actual work.

Item—Any spare part, consumable, equipment, or material. May include entire component, valve, motor, instrument, gasket, adhesive, seal, etc.

Hierarchy—A visual representation of a system or sub-system which reflects the (sub-)system name/ abbreviation, parent/child relationships, asset descriptions, asset category abbreviations, and assets deemed worthy of tracking maintenance, work, or problems against.

Inspection—To examine; to perform a critical visual observation or check for specific conditions: to test the condition.

Job Specific Tools—Tools that are of high monetary value or in short supply that are used on an infrequent basis.

Key Performance Indicators (KPI's)—Measures within key areas of an organization for the purpose of determining performance against targets over time. Key Performance Indicators are sometimes referred to as Metrics.

Laydown Area—Area on or close to a job site, designated and approved by the facility to be used by maintenance personnel for the materials and equipment used on the maintenance job, for the duration of the job.

Lessons Learned—Vital information collected, maintained and disseminated from prior experiences of organizational loss. Typically, Lessons Learned are part of a formalized organizational process that includes Root Cause Failure Analysis.

Life Cycle (LC)—The stage in the life of an asset.

Life Cycle Cost (LCC)—The total of all costs throughout the life cycle of an asset at any given point in time. The costs include; allocated maintenance, parts used/stored, downtime, energy, overhead and depreciation. These costs typically take into account the time value of money.

Life Cycle Plan—An analysis and description of the major events and activities in the life of a functional unit from planning through decommissioning and site restoration. The plan documents the history of the functional unit and forecasts future activities, including major line item and expense projects and their duration, relationships, and impact on life expectancy. The plan also describes maintenance practices and costs.

Log Sheet—A controlled document that is used to record/track information at any frequency of collection.

Maintainable Asset (least)—An asset or equipment item that is maintainable. The Least Maintainable Asset has been determined that further breakdown into components or parts is unnecessary because either doing so would not be in line with the goals of this maintenance program.

Maintenance—The proactive and reactive day-to-day work that is required to maintain and preserve facilities and SSCs within them in a condition suitable for performing their designated purpose, and includes planned or unplanned periodic, preventive, predictive, seasonal or corrective (repair) maintenance.

Maintenance Backlog—The number of overdue incomplete maintenance Work Orders for either planned or unplanned maintenance activities, including backlog due to aging and deterioration of facilities or facilities related equipment not accomplished at the end of the fiscal year.

Maintenance Importance Generator—A computerized system using predetermined rules to compare data on a Work Request/Work Order and to establish relative-importance ranking for each maintenance job.

Maintenance Management—The administration of a program utilizing such concepts as organization, plans, procedures, schedules, cost control, periodic evaluation, performance indicators and feedback for the effective performance and control of maintenance with adequate provisions for interface with other concerned disciplines such as health, safety, environmental compliance, quality control, and security. All work done in conjunction with existing DOE facilities and property is either maintenance (preserving), repair (restoring), service (cleaning and making usable), or improvements (modifications). The work to be considered under the DOE nuclear safety maintenance management program includes all of these attributes.

Maintenance Plan—A document providing direction to comply with orders, directives, laws or meet operational objectives in a consistent manner. A plan provides adequately detailed roles, responsibilities, action steps, and requirements for conducting maintenance activities.

Maintenance Prevention—Designs intended for the purpose of reducing or eliminating maintenance actions.

Maintenance Procedure—Written instructions provided to maintenance workers directing them on how to perform specific tasks. The level of detail of these instructions is based on the complexity of the task, special engineering considerations/specifications, and skill levels of the workers performing the task.

Maintenance Procedure (MP) Revision 0—A MP developed using written information from one or more sources that has not undergone field verification and validation (V&V). This document has not yet been attached in ECMS.

Maintenance Procedure (MP) Revision 1—A MP which evolved from revision 0 to the next revision level as the result of one execution of field V&V efforts using skilled labor (i.e., NIF Maintenance Technicians, Plant Engineering, outside contractors). The revision 1 level MP includes management-approved comments that were noted by skilled labor during the first field V&V of a MP at the revision 0 level. This document resides in ECMS.

Maintenance Strategy—The approach by which maintenance resources are allocated to assets. Examples of Maintenance Strategies; Run To Failure (RTF), Failure Finding (FF), Time Directed (TD) and Condition Directed (CD).

Maintenance Work Package—A consolidated document used by maintenance organizations that contains all the necessary procedures, instructions and requirements to safely and effectively perform a maintenance task. A maintenance task should not be considered complete until all of the requirements of the Maintenance Work Package have been satisfied.

Master Equipment List (MEL)—Detailed master list of equipment, components, and structures to be included in the maintenance program. This list includes both safety-related and non-safety-related systems and equipment.

Material Deficiency—A system or component with a physical defect that does not conform to a specified standard.

Mean Time Between Failures (MTBF)—The average or expected value of operating time between failures of a repairable item.

Mean Time To Repair (MTTR)—Average time between an asset failure and asset repair.

Measuring & Test Equipment (M&TE)—Includes all devices or systems used to calibrate, certify, measure, gauge, troubleshoot, test, or inspect in order to control data or to acquire data to verify conformance to specified requirements. M&TE does not include permanently installed facility instrumentation, nor does it include test equipment used for preliminary checks where data obtained are not used to determine acceptability or verify conformance to established criteria.

Metrics—See Key Performance Indicators

Minor Maintenance—Maintenance actions for deficiencies on facilities, equipment or parts where all the following conditions are met.

- The component is not important to safety. If the component is important to safety, the portion or part being worked does not perform or affect safety or a safety function and is physically isolated.
- The component or part does not perform an environmental qualification (EQ) function.
- The integrity of the component will not be violated.
- Material substitution will not be involved.
- Disassembly of the component or part will not be required.
- Welding will not be performed on a component or part of the component that is important to safety or seismically mounted.
- Welding will not be performed on a pressure vessel.

- Welding will not be performed on system piping.
- A lockout/tagout will not be required.
- The work performed is of such a minor nature that a written procedure is not required. However, if a procedure exists, it may be used.
- "Documented" post maintenance testing will not be required.
- The work is of such a simple nature that a detailed Maintenance Work Package and job planning package are not required.

Mission Critical—An SSC that is critical to DOE/facility mission (production related, safety-related or safety significant).

Operational Tempo—The pace (i.e., continuous, batch, 24/5, etc.) of operations. The Operational Tempo typically determines which maintenance strategies will be utilized within a facility in support of operational requirements.

Outage—A condition that exists whenever normal production operations have ceased and all SSCs and processes are shutdown, properly aligned, or otherwise in an appropriate status, as a result of planned or unplanned occurrences.

Parent—A particular level in a structure or grouping of assets responsible for ownership of child(ren). Parent/child relationships are important for rollup of maintenance costs.

Parts—Items typically identified in a manufacturer's manual for an asset and are worn during the asset life cycle. Parts are asset manufacturer and model number specific. Examples of parts; bearings, shafts, seals, etc.

Performance Criteria—A condition or set of conditions that, when satisfied, indicate successful completion of the performance objective.

Performance Measures—Any evaluation, comparison, or judgment toward meeting the performance objective.

Performance Monitoring—Systematic monitoring and trending of the performance of selected facility SSCs to measure and assess the impact of any performance changes on overall facility efficiency, reliability, and availability.

Performance Objectives—A statement of wants, needs, and expectations of customers that sets the direction for all contract effort.

Performance-Based Maintenance—Tailoring the preservation or maintenance of SSCs in terms of measurable (i.e., in terms of quality, timeliness and quantity) performance standards and objectives where appropriate (i.e., use of a "graded approach").

Periodic Maintenance—Preventive, predictive or seasonal maintenance activities performed on a routine basis (typically based on operating hours or calendar time) that may include any combination of external inspections, alignments or calibrations, internal inspections, overhauls, and SSC replacements.

Personal Property—Generally, capitalizable property that can be moved or that is not permanently affixed to and part of real estate. Generally, items remain personal property if they can be removed without seriously damaging or diminishing the functional value of either the capitalizable property or the real estate. Examples of personal property are shop equipment and automated data-processing and peripheral equipment.

NOTE: Real property includes facilities (e.g., buildings and other structural facilities) and personal property that is an integral part of real property (related personal property) or is related to, designed for, or specifically adapted to the functional or productive capacity of the real property, the removal of which would significantly diminish the economic value of the real property or the related personal property itself. Examples of related personal property are communication systems and telephone systems. Real property may also include triple-wide trailers or modular units joined together so that the structure is not portable and cannot be relocated without being dismantled and thus losing its identity. Normally, common-use items, including but not limited to general-purpose furniture, utensils, office machines, office supplies, and general-purpose vehicles, are not considered related personal property.

Physical Assets—All DOE-owned or DOE-used and -controlled land, land improvements, structures, utilities, motor vehicles, equipment, and components are included.

Planned Maintenance—Preventive or seasonal maintenance activities performed before SSC failure that may be initiated by predictive or periodic maintenance results, through vendor recommendations, or by experience/lessons learned. These include actions such as scheduled cold weather protection, valve repacking, replacement of bearings as indicated from vibration analysis, major or minor overhauls based on experience factors or vendor recommendations, and replacement of known life-span components. For example, repacking a valve because of packing leakage would be corrective maintenance, but scheduled repacking before leakage would be planned maintenance.

Plan of Day (POD)—A document that shows the allocation of workers to particular Work Orders and Work Permits.

Planning—Activity devoted to clearly identify, define, and determine courses of action, before their initiation, necessary to achieve predetermined goals and objectives.

Post-Maintenance Test (PMT)—Applicable and appropriate testing performed following maintenance to verify that a particular SSC, piece of equipment, or process performs its intended function based on its design criteria and that the original deficiency has been corrected and no new deficiencies created. In some cases, the extent of a particular PMT may extend beyond the component or piece of equipment that has been repaired, replaced or modified to complete systems or processes, depending on the type of maintenance action performed and the affect that the component or piece of equipment has on the total system or process.

Predictive Maintenance (PdM)—The actions necessary to monitor; find trends; and analyze parameters, properties, and performance characteristics or signatures associated with SSCs, facilities, or pieces of equipment to discern whether a state or condition may be approaching that is indicative of deteriorating performance or impending failure, where the intended function of the SSCs, facilities, or pieces of equipment may be compromised. Predictive maintenance activities involve continuous or periodic monitoring and diagnosis to forecast component degradation so that "as-needed" planned maintenance can be initiated before failure. Not all SSC, facility, or equipment conditions and failure modes can be monitored and diagnosed in advance; therefore, predictive maintenance should be selectively applied. Examples of Predictive Maintenance parameters: vibration, oil, thermal energy and process.

Preventive Maintenance (PM)—Conscious steps taken in terms of allocating resources to prevent the unplanned failure of an asset. Includes all those planned, systematic, periodic, and seasonal maintenance actions taken to prevent SSC or facility failures, to maintain designed-in operating conditions, and to extend operating life. Preventive Maintenance can include: Failure Finding, Corrective Maintenance, Time Directed and Predictive Maintenance. The PM process takes into account the inevitability of failures in any simple or complex piece of equipment.

Primary Standards—Calibrated by the National Institute of Standards and Technology (NIST) or other authoritative reference source. Its use should be restricted to the standards laboratory.

Priority—A pre-determined magnitude of importance based upon criterion within one or more subject areas within an organization. Basically, the relative importance of a need with respect to other needs.

Proactive Maintenance—A proactive approach, as opposed to a reactive approach to the allocation of maintenance resources in an attempt to prevent unplanned asset failure.

Problem Component—A component whose past failures have caused a significant adverse impact on safety system availability, electrical generation, or maintenance cost.

Property, Plant, and Equipment—Tangible assets that meet the capitalization criteria, that are not intended for sale in the ordinary course of operations; and they have been acquired or constructed with the intention of being used, or being available for use by the entity.

Reactive Maintenance (RM)—The allocation of maintenance resources as a result of an unplanned asset failure.

Real Property or Real Estate—Real property includes land, improvements on the land, or both, including interests therein. All equipment or fixtures (such as plumbing, electrical, heating, built-in cabinets, and elevators) that are installed in a building in a more or less permanent manner or that are essential to its primary purpose are usually held to be part of real property.

Recall Program—A system to recall and service M&TE.

Related Personal Property—Related personal property means any personal property that, once installed, becomes an integral part of the real property in which it is installed or is related to, designed for, or specially adapted to the functional or productive capacity of the real property. The removal of related personal property will significantly diminish the economic value of the real property or the related personal property. Examples of related personal property are communications and telephone systems.

Reliability—The probability that a component or system should perform its functions for a specified period of time when used within established operating parameters.

Reliability, Availability, Maintainability (RAM)—The metrics used to measure the overall performance of the NIF Facility.

Reliability Centered Maintenance—A proactive systematic decision logic tree approach to identify or revise preventive maintenance tasks or plans to preserve or promptly restore operability, reliability and availability of facility SSCs; or to prevent failures and reduce risk through types of maintenance action and frequency selection to ensure high performance. Reliability centered maintenance is the performance of scheduled maintenance for complex equipment, quantified by the relationship of preventive maintenance to reliability and the benefits of reliability to safety and cost reduction through the optimization of maintenance task/frequency intervals. The concept relies on empirical maintenance task/frequency intervals to make determinations about real applicable data suggesting an effective interval for task accomplishment. The approach taken to establish a logical path for each functional failure is that each functional failure, failure effect, and failure cause be processed through the logic so that a judgment can be made as to the necessity of the task, and includes (1) reporting preventive maintenance activities, plans, and schedules; (2) optimizing / calculating the preventive maintenance interval by balancing availability, reliability, and cost; (3) ranking preventive maintenance tasks; (4) accessing preventive maintenance information from piping and instrumentation drawings (P&IDs); (5) accessing preventive maintenance and other maintenance data; (6) listing recurring failure modes/parts, including failure to start and failure to run; (7) calculating and

monitoring SSC availability; (8) accessing preventive maintenance procedures, and (9) keeping track of preventive maintenance cost.

Repair—The restoration of failed or malfunctioning equipment, system, or facility to its intended function or design condition (see Corrective Maintenance).

Required Maintenance Cost—Current maintenance needs cost estimate.

Rework—Any prior completed work which needs to be re-done one or more times.

Root Cause—The determination of the causal factors preceding an SSC failure or malfunction - that is, discovery of the principal reason why the failure or malfunction happened leads to the identification of the root cause. The preceding failure or malfunction causal factors are always events or conditions that are necessary and sufficient to produce or contribute to the unwanted results (failure or malfunction). The types of causal factors are (1) direct causes, (2) contributing causes, and (3) root causes. The direct cause is the immediate event or condition that caused the failure or malfunction. Contributing causes are conditions or events that collectively increase the likelihood of the failure or malfunction, but that individually do not cause them. Thus, root causes are events or conditions that, if corrected or eliminated, would prevent the recurrence of the failure or malfunction by identifying and correcting faults (often hidden) before an SSC fails or malfunctions.

Root Cause Failure Analysis (RCFA)—A formalized process within an organization to analyze and determine the underlying cause of a problem. Typically, Root Cause Failure Analysis is part of a formalized organizational process that includes Lessons Learned.

Run To Failure (RTF)—A maintenance strategy which involves the conscious decision to not allocate resources to preserve asset functionality. In other words, no maintenance will be performed on the asset. Examples of assets typically deemed for RTF; restroom exhaust fans and lighting ballasts.

Scheduling—The process of determining when activities will take place depending on defined durations and precedent activities. Schedule constraints specify when an activity should start or end based on duration, predecessors, external predecessor relationships, resource availability, or target dates.

Secondary Standards—Calibrated by comparison with a primary standard of the same measurement modes. It should be used by laboratory personnel and stored in the standards laboratory. Use by other than standards laboratory personnel should be limited to that approved by the applicable manager.

Skill of the Craft—A defined level of technical proficiency for a worker performing a particular job that is verifiable through some form of qualification or supervisory knowledge.

Staging Areas—Area designated and approved by the maintenance supervisor, for staging parts, materials, and supplies until a maintenance job is ready to work.

Standards Laboratory—A standards laboratory is a central on-site facility that maintains, calibrates, and certifies most of the facility portable instrumentation and test equipment.

Storage Controls—Controls applied during purchasing, receiving, packaging, and storing of items to ensure that they are maintained properly.

Storeroom—Any facility designed or used for receiving, storing, and issuing items.

Structures, Systems and Components (SSCs)—Physical items designed, built, or installed to support the operation of the facility. A structure is an element or a collection of elements to provide support or enclosure such as a building, free standing tank, basin, dike, or stack. A system is a collection of components assembled to perform a function such as piping; cable trays; conduits; or

heating, ventilation, and air conditioning. A component is an item of equipment such as a pump, valve, or relay or an element of a larger array such as a length of pipe, elbow, or reducer.

Subsystem—A logical grouping of assemblies, subassemblies, components, or assets. At NIF , subsystems are listed in the Unified Systems Hierarchy and are identified by a given a name/ abbreviation.

Surveillance Test—Functional tests of installed equipment and/or systems to satisfy technical safety requirements.

System—see Subsystem.

System Maintenance and Reliability Tracking (SMaRT)—Computerized maintenance management system computer software based upon Datastream7i for the purpose of supporting maintenance management.

Technical Hierarchy—See Hierarchy.

Technical Support—The engineering, design, computer support, training, warehousing, fabrication, procurement, operations, quality assurance, material and parts control and availability, specialized inspections, planning, or other such support needed to develop and implement a successful maintenance management program that provides an efficient and continuous operating facility.

Time Directed (TD)—A maintenance strategy which involves asset intrusive tasks that occur based upon calendar time, run time, revolutions and cycles. Typical asset intrusive maintenance tasks include; oil / belt change, greasing, etc. The Time Directed maintenance strategy is asset intrusive.

Tool—Device used by a worker to enact work on a system, Subsystem, or component (e.g. Wrench, Power Tool, or Digital Multi-Meter). Also may be a device that supports activities allowing workers to conduct work in a safe manner and/or more efficiently (e.g., Flashlight, Radio, or Ladder).

Tools and Equipment—All noninstalled items commonly used to perform or assist in maintenance work functions within a facility. These items are not normally designed to perform highly specialized tasks and include such items as hand tools, power tools, electric cords, hoses, chain falls, scaffolding, ladders, and calibrated test equipment

Tool Storage Areas—Area authorized and controlled for the issuance and storage of tools and equipment designated for use in a facility.

Trending—A systematic analysis of an SSC or facility performance to categorize and establish operating history that enables graphic depiction and simulation of results in measurable terms such as cause and effect, failures, production output or capacity, cost or other subjects of interest.

Troubleshooting—The process of locating and identifying SSC malfunctions through deductive and inductive reasoning and/or testing. The process may include (but is not limited to) activities such as taking readings, pulling fuses, stroking valves, changing electronic modules, partial or complete disassembly of a component, etc.

Unified System Hierarchy—A representation of the NIF as a system at the top or highest level down to the primary sub-systems which support the basic functions of the NIF. At lower levels, under the Unified System Hierarchy, are the Sub-system Hierarchies.

Utility—A system, or any of its components, that generates and/or distributes (via pipelines, wires, buses, or electromagnetic waves) a commodity or service to itself and/or to other facilities.

Validation—Validation is and evaluation as to whether the procedure provides sufficient and understandable guidance and direction to the personnel and that it is compatible with the equipment or subsystem being maintained. Refer to Section 6.3.

Value Added—A decision-making process that leads to an improvement in an operation or process, based on effectiveness, efficiency, cost-effectiveness safety, etc.

Wearout—The normal degradation process that is a function of operating time.

Working Standards—Calibrated in the facility with a primary or secondary standard of the same measurement mode, or calibrated using other measurement modes. It generally should be used in day-to-day activities, (mainly in direct field applications where direct/ready access is required or when ALARA considerations exist), to certify product certification equipment and instruments in the maintenance recall program using approved procedures.

Work Request and/or Work Order (WR/WO)—The WR/WO is a means of obtaining maintenance services available on both paper and electronic mediums and initiated by maintenance customers. Issued to Maintenance Planners and Estimators and used to define, plan, and execute maintenance activities. Documentation of a deficient equipment condition, requires detailed documentation of work performed, spare parts, procedures, or testing to verify maintenance was performed correctly. The WR/WO may also serve as documentation for completion of minor maintenance activities such as lubrication, light bulb replacement, etc. (It could also be called a maintenance job request.)

APPENDIX B: ACRONYMS

These acronyms are specific to the scope of this maintenance plan and are in addition to the NIF standard acronyms. Definitions for the acronyms are in Appendix A: Definitions.

AMP—Amplifier Cooling

ARG—Argon

BAAQMD—Bay Area Air Quality Management District

BLD—Building Structures

BUS—Beampath Utility System

CA—Compressed Air

CCP—Clean Construction Protocol

CD—Condition Directed

CDA—Clean, Dry Air

CF—Conventional Facility

CHW—Chilled Water

CI—Configuration Item

CM—Corrective Maintenance

CMMS—Computerized Maintenance Management System

COM—Commissioning Operations and Maintenance

CSF—Cavity Spatial Filter

CSM—Configured System Manager

CSS—Credited Safety Systems

CV—CargoVator Conveyance

CW—City Water

DDC—Direct Digital Controls

DI—De—Ionized water

DIAV—Diagnostic Vacuum

DM—Deferred Maintenance

DOE —Department of Energy

DW—De-Mineralized Water

DWTL—Daily Work Team Leader

EA—Exhaust Air

ECM—Experience Centered Maintenance

ECMS—Enterprise Configuration Management System

EM—Emergency Maintenance

EPD—Environmental Protection Department

EUS—Electrical Utility System

EVAC—Emergency Voice/Paging/Security Alarm

FAS—Fire Alarm System

FCOM—Facility Commissioning, Operations, and Management

FF—Failure Finding

FMEA — failure mode and effects analysis

FOAC—Final Optics Assembly Cooling

FOAV—FOA Vacuum

FOM—Frequency of Maintenance

FPW—Fire Protection Water

FSP—Facility Safety Plan

HA—Backfill Air

HVAC—Heating, Ventilation and Air Conditioning

HW—Hot Water

ICCS—Integrated Computer Control System

ICS—Industrial Controls System

ISMS — Integrated Safety Management System

IT—Information Technology

KPI—Key Performance Indicators

LC—Life Cycle

LCC—Life Cycle Cost

LCS—Low Conductivity Water

LH—Lifting, Handling, and Conveyance

N2—Liquid Nitrogen

LoCoS—Location, Component and State

LRU—Line Replaceable Unit

LTG—Facility Lighting

LTRAIN—Livermore Training Records and Information Network

MA—Main Amplifier

MEL — master equipment list

MIP — maintenance implementation plan

MP—Maintenance Procedure

MT&E—Measurement and Test Equipment

MTBF—Mean Time Between Failure

MSDS — Material Safety Data Sheet

MTTR—Mean Time To Repair

NIST — National Institute of Standards and Technology

OJT — on-the-job training

P&ID — piping and instrumentation drawing

O&M—Operations and Maintenance

OSP—Operational Safety Plans

PA—Power Amplifier

PABTS—Preamplifier Beam Transport System

PAM—PreAmplifier Module

PdM—Predictive Maintenance

PDSV—Precision Diagnostic System Vacuum

P&ID—Piping and Instrumentation Diagram

P&S—Planning and Scheduling

PEPC—Plasma Electrode Pockels Cell

PEV—PEPC Vacuum

PG—Process Gas

POD—Plan of the Day

PM — Preventive Maintenance

PMT — Post Maintenance Test

PPE—Personal Protective Equipment

PW—Process Water

RAM—Reliability, Availability, Maintainability

RCFA—Root Cause Failure Analysis

RCM—Reliability Centered Maintenance

RI—Responsible Individual

RM—Reactive Maintenance

RMDE—Roving Mirror Diagnostic Enclosure

RMS—Requirements Management System

RTF—Run to Failure

SF—Spatial Filter

SFV—SF Vacuum

SMaRT—System Maintenance and Reliability Tracking

SPA—Safe Plan of Action

SS—Sewer and Retentions

SSC— Structures, Systems and Components

SSM—Subsystem Manager

SW—Storm Water

SWPPP—Storm Water Pollution Prevention Plan

SY—Switchyard

TB—Target Building

TCV—Target Chamber Vacuum

TCSS—Target Chamber Service System

TD—Time Directed

TSF—Transport Spatial Filter

TW—Tower Water

TWC—Tempered Water Cooling

USH—Unified System Hierarchy

V&V—Verification and Validation

w.c.—water column

WO—Work Order

WR—Work Request

The acronyms contained in the *NIF Operations Management Plan*[1] append and supersede those contained in this appendix.

APPENDIX C: CRITICALITY VALUES

Criticality = OI x RT x CI

The factors for this formula are listed below:

- RT = System/equipment replacement time for failures
  - 1—most time
  - 2—average
  - 3—least time
- CI (added term)
  - 1—CI items 1
  - 2—no CI items
- OI (Operational Impact)

1. Failed Shot—We count a shot as "Failed" when the shot actually goes off (normally as determined by the facility timing transmitter firing) but for some reason we did not get the required (and usable) data for the shot. Usually this means that we don't get data on a primary diagnostic for some reason, or major hardware fails (like a power conditioning module doesn't fire). This is a somewhat "grey" definition.
2. Lost Shot—We nominally have time available to schedule 2 system shots per operating shift. We assume this rate (2 shot slots/shift, 4 per day with 2 shifts) as the planned rate. This is true even though we may under good conditions get more than 4 a night, depending on the type of shots. Based on our shift plan for the night (at the end of day shift) we may "Plan" less than 4 shots; if so, it is listed as "planned downtime". We then count "lost" shots for any shots that were planned that don't get done (max 4 per night). Note that sometimes we shoot backup shots that weren't planned if the primary bundle is unavailable for some reason. We don't count that as a "lost" shot because the shot slot was still used effectively. We then typically list the cause as that item(s) that were the primary cause for the delay or inability to operate the required bundles. Again, this is a somewhat "fuzzy" definition applied as consistently as possible.
3. No shot impact.

APPENDIX D: SUBSYSTEMS, SYSTEM LEVEL MAINTENANCE PLANS, AND HIERARCHIES

Abbreviation	System Description	Subsystem-Level Maintenance Plan (Reference ECMS)	Subsystem Hierarchy
CF	*Conventional Facilities*	*None planned*	*None planned*
BLD	Building Structures	NIF-5018541	NIF-5018906
CHW	Chilled Water System	NIF-5018542	NIF-5018908
CW	City Water System	NIF-5018543	NIF-5018909
DI	De-ionized Water "OAB"	NIF-5018545	NIF-5018911
DW	Demineralized Water System	NIF-5018546	NIF-5018912
EUS	Electrical Utility System	NIF-5018547	NIF-5018913
EVAC	Evacuation System (Emerg Voice/Paging/Alarm Systems)	NIF-5018548	NIF-5018914
FAS	Fire Alarm System	NIF-5018549	NIF-5018915
FPW	Fire Protection Water System	NIF-5018550	NIF-5018916
	Air Handling Systems	*None planned*	*None planned*
DBE	Diagnostics Building Exhaust		
HVAC	HVAC	NIF-5018553, NIF-5018579, NIF-5018893	NIF-5018917
HVAC	Target Bay Exhaust		
HVAC	Target Bay HVAC		
HW	Hot Water System	NIF-5018554	NIF-5018918
LCW	Low Conductivity System	NIF-5018555	NIF-5018919
LH	Lifting, Handling & Conveyance	NIF-5018556	NIF-5018920
LTG	Facility Lighting	NIF-5018557	NIF-5018921
PMS	Particle Monitoring System		
PW	Process Water System	NIF-5018558	NIF-5018922
RADIO	Communications		
SAFE	Safety Equipment		
SS	Sewer and Retention	NIF-5018559	NIF-5018923
SW	Storm Water	NIF-5018560	NIF-5018924
TW	Tower Water System	NIF-5018561	NIF-5018925
LAND	Landscaping and Grounds	NIF-5024642	
	Laser Systems	*None planned*	*None planned*
LSS	*Light Source Systems*	*None planned*	*none*
1wLSL	1w Light Source Laser		
LSL	LM1/LM3 Light Source Launcher System		
375LS	375nm Light Source		
BLS	*Beam Line Systems*	*None planned*	*None planned*
MA	*Main Amplifier*	*None planned*	*None planned*
MABPH	MA Beampath		
LM1	Laser Mirror 1 LRUs		
MASLAB	Amplifier Slab LRUs		
MAFL	Amplifier Flashlamp LRUs		
PER	*Periscope*	*None planned*	*None planned*
PERBPH	Periscope Beampath	*None planned*	*None planned*
PEPC	Plasma Electrode Pockel Cell System	*None planned*	*None planned*
PEPCLRU	Plasma Electrode Pockel Cell (PEPC) LRUs		
PEPCPPG	Plasma Pulse Generator		
PEPCSPG	Switch Pulse Generator		
PEPCMISC	PEPC Misc		
LM2	Laser Mirror 2 LRUs		

Abbreviation	System Description	Subsystem-Level Maintenance Plan (Reference ECMS)	Subsystem Hierarchy
LM3	Laser Mirror 3/Pol LRUs		
PA	*Power Amplifier*	*None planned*	*None planned*
PABPH	PA Beampath		
PASLAB	Amplifier Slab LRUs		
PAFL	Amplifier Flashlamp LRUs		
CSF	*CSF*	*None planned*	*None planned*
CSFBPH	CSF Beampath		
SF1	Spatial Filter 1 LRUs		
SF2	Spatial Filter 2 LRUs		
TWR	CSF Tower LRUs		
TSF	*TSF*	*None planned*	*None planned*
TSFBPH	TSF Beampath		
SF3	Spatial Filter 3 LRUs		
SF4	Spatial Filter 4 LRUs		
TSFA	TSF Alignment Tower LRUs		
TSFD	TSF Diagnostic Tower LRUs		
RMDE	*Roving Mirror Diagnostic Enclosure*	*None planned*	*None planned*
RMDEBPH	RMDE Beampath		
RMDA	Roving Mirror Diagnostics Assembly		
RMDEGV	RMDE Gate Valves		
PDSB	*Precision Diagnostic System Beampath System*	*None planned*	*None planned*
PDSBBPH	PDS Beampath		
PM1	Pickoff Mirror 1		
PM2	Pickoff Mirror 2		
PM3	Pickoff Mirror 3		
PM7	Pickoff Mirror 7		
SYB	*Switch Yard Beampath System*	*None planned*	*None planned*
SYBBPH	SY Beampath		
SYBTAB	TTW Argon Barriers		
LM4	Laser Mirror 4 LRUs		
LM5	Laser Mirror 5 LRUs		
TBB	*Target Bay Beampath System*	*None planned*	*None planned*
TBBBPH	TB Beampath		
LM6	Laser Mirror 6 LRUs		
LM7	Laser Mirror 7 LRUs		
LM8	Laser Mirror 8 LRUs		
FOS	*Final Optical System*	*None planned*	*None planned*
FOA	Final Optical Assembly	*None planned*	*None planned*
IOM	Integrated Optics Module	*None planned*	*None planned*
1WCPP	1w Continuous Phase Plate		
2WCPP	2w Continuous Phase Plate		
GDS	Grating Debris Shield		
TCVW	Target Chamber Vacuum Window		
PR	Polarization Rotator		
SHG	Second Harmonic Generator		
THG	Third Harmonic Generator		
WFL	Wedge Focus Lens		
TC	Target Chamber		
ILS	*Injection Laser Systems*	*None planned*	*None planned*
ISP	Input Sensor Package		
LI	Lower Injection System		
PABTS	PreAmplifier Beam Transport System		
PAM	PreAmplifier System		
PCU	PAM Power Conditioning Unit		

Abbreviation	System Description	Subsystem-Level Maintenance Plan (Reference ECMS)	Subsystem Hierarchy
MOR	*Master Oscillator (MOR)*		
FODI	*Final Optics Damage Inspection Systems*		
PEDGE	Precision Diagnostics System Edge Illumination System		
EDGE	Target Bay Edge Illumination System		
FODIS	Final Optics Damage Inspection Systems		
PFODI	Precision Diagnostics System Final Optics Damage Inspection Systems		
SIDE	Side Illumination and Damage Evaluation System		
LD	*Laser Diagnostics*		
DRD	Drive Diagnostics		
3WPS	3w Power Sensor		
3WCAL	3w Calorimeter		
ISPD	ISP Diagnostics		
1WPS	1w Power Sensor		
QBRS	Quad Back Reflection Sensor		
MCD	Mid Chain Diagnostic		
PDS	Precision Diagnostic System (PDS)		
RCAL	Roving Calorimeters		
OSP	Output Sensor Package (OSP)		
RO	Optical Relay to Output Sensor		
ARC	*Advanced Radiographic Capability (Compressor)*		
PCS	*Amplifier Power Conditioning System*		
PCSCON	PCS Controls		
CCRS	*Target Experimental Systems*		
TP	Chamber Center Reference System		
TPC	Target Positioner		
TASP	Cryo TARPOS		
ITAS	Target Alignment Sensor Positioner		
ITIC	Interim Target Alignment System		
DIM00	Ignition Target Insertion Cryostat		
CCRS	DIM 0-0		
DIM9045	DIM 90-45		
DIM90315	DIM 90-315		
DIMDU	DIM Diagnostic Utilities		
FODIP	FODI Positioner		
SXIU	SXI-Upper Positioner		
SXIL	SXI-Lower Positioner		
OPAS	Opposed Port Alignment System		
DECON	Decontamination Area Systems		
CIVS	Chamber Interior Viewing System		
	Target Diagnostic Systems		
FABS31	Full Aperture Backscatter Diagnostic B31		
FABS36	Full Aperture Backscatter Diagnostic B36		
FFLEX	Filter Fluorescer X-Ray Diagnostic		
CTS	Cross Timing System		
NBI	Near Backscatter Imaging Diagnostic		
PROTEX	PROTEX		
NTOF	Neutron Time of Flight		
NIS	Neutron Imaging System		
MRS	Magnetic Recoil Spectrometer		
ACT	Activation Diagnostic		
RCD	Radio Chemistry Diagnostic		

Abbreviation	System Description	Subsystem-Level Maintenance Plan (Reference ECMS)	Subsystem Hierarchy
SXI	Static X-ray Imager		
SXDB	Streak X-ray Detector - Backup		
FXI	Flexible X-ray Imager		
DANTE	DANTE		
VISAR	VISAR		
BUS	*Beampath Utility Systems -including B582 and Utility Pads*	*None planned*	*None planned*
AMP	Amplifier Cooling & Purge System	NIF-5018562	NIF-5018926
ARGPAD	Argon Supply System	NIF-5018563	NIF-5018927
ARGDIST	Argon Distribution		
ARGGK	Argon Gas Knives		
TABAPCATABAP	Tab Air Purge		
CA	Compressed Air System	NIF-5018564	NIF-5018928
CDA	Clean Dry Air System (SA/SAH)	NIF-5018565	NIF-5018929
BUS-CV	Cargovators	NIF-5018566	NIF-5018930
BUS-DIAV	Diagnostic Vacuum System	NIF-5018567	NIF-5018931
DFV	Diagnostic Foreline Vacuum		
DPV	Diagnostic and Positioner Ventilation		
EA	Exhaust Air System	NIF-5018568	NIF-5018932
FOAC	FOA Cooling System	NIF-5024188	NIF-5018933
FOAV	FOA Vacuum System	NIF-5018570	NIF-5018934
MISC	Miscellaneous Systems		
HA	Humid Air System (Backfill Air)	NIF-5018571	NIF-5018935
N2	Liquid Nitrogen System	NIF-5018572	NIF-5018936
PAMC	PAM Chillers		
PDSV	PDS Vacuum System	NIF-5018573	NIF-5018937
PEV	PEPC Vacuum System	NIF-5018574	NIF-5018938
PABVAC	Pre Amplifier Beam Transport System (PABTS) Vacuum	NIF-5027975	
PG	Process Gas	NIF-5018575	NIF-5018939
PHA	Purged Storage Humid Air		
PPCC	Plenum Plug Contamination Control		
SFV	Spatial Filter Vacuum System	NIF-5018576	NIF-5018940
TCV	Target Chamber Vacuum System	NIF-5018577	NIF-5018942
TCSS	Target Chamber Service System	NIF-5018844	NIF-5018943
TPS	Tritium Processing System		
TWC	Tempered Water Cooling System	NIF-5018578	NIF-5018944
UDPE	UDP Exhaust		
TH	*Transport & Handling*		
THT	Transporters		
THTGS	Transporters Guidance System		
THCAN	Canisters		
IOMCART	PAM Carts		
PAMCART	LM4-8 Handling		
CONTROLS	*Control Systems and Software Applications*		
CABLES	Cable Plant		
RACKS	Racks		
ICS	Utility Integrated Industrial Control System		
ISS	Integrated Safety Systems		
ACS	Access Controls System		
SIS	Safety Interlock System		
DDC	Distributed Digital Controls	NIF-5018544	NIF-5018910
SEC	Integrated Security Systems		

Abbreviation	System Description	Subsystem-Level Maintenance Plan (Reference ECMS)	Subsystem Hierarchy
RMS	Radiation Monitoring System		
SMS	Stack Monitoring System		
TAM	Tritium Area Monitoring		
GAM	Gamma Area Monitoring		
HCS	HMMS Controls System		
HMMA	*Hazardous Materials Management Area Systems*		
CWW	Contaminated Waste Water		
HDW	HMMA Demineralized Water		
HPL	Health Physics Lab Systems		
WWS	Water Wash Systems		
CCE	Contamination Control Enclosures		
MSA	*Maintenance and Services*		
OAB	Optics Assembly Building Equipment		
PAMMA	PAM Maintenance Area (PAMMA) Equipment		
TOOLS	Tools		
MTE	Measuring and Test Equipment		
PS	Precision Surveying		

APPENDIX E: IMPLEMENTATION PLAN FOR EQUIPMENT AND PIPING LABELING

***IMPLEMENTATION*:**

1. Components Requiring Labeling:

Facility equipment and piping associated with systems that could produce a significant impact on health, safety, the environment, or programs shall be labeled in accordance with the Plant Engineering Standards PEL-M-11009, (Rev. G or latest revision) (for equipment) and PEL-M-02650, (Rev. A or latest revision) (for piping and valve identification).

2. Equipment naming convention for equipment listed in SMaRT

Refer to NIF procedure, *Assignment of NIF Operations SMART Equipment Numbers*, NIF-5019033,[41] for the naming convention of equipment listed in SMaRT.

3. Maintaining List of Equipment and Piping Requiring Labeling

A general list of equipment and piping that requires labeling is located in Appendix E. For specific items that require labels, refer to the subsystem-level maintenance plans.

4. Label Information and Placement

Follow the guidelines for label requirements, label placement, and abbreviations described in Plant Engineering Standards PEL-M-11009, (Rev. G or latest revision) for equipment, and PEL-M-02650 (Rev. A or latest revision) for piping and valve identification.

5. Worker Training

Field Managers are responsible for ensuring that workers operating or performing maintenance shall be aware of this labeling nomenclature.

6. Replacing Labels

Lost or damaged labels noted during the performance of work shall be noted on the Work Order. A Reactive Work Order will be entered into SMaRT during the Work Order Close-out Process to correct the condition. Deficiencies will be corrected quickly, and a record of the corrective action will be logged in the SMaRT database.

EQUIPMENT FIELD LABELS AND THE SMART NUMBERING SYSTEM CROSS-REFERENCING:

For CF/BUS systems, equipment is labeled in the field and also is assigned a label in the SMaRT System. For the following reasons, the field equipment label may not match the SMaRT label:

- Although significant effort has been made, equipment located in the field may not have a unique field tag number. However, the SMaRT database requires a unique number to properly function.
- Some equipment has been found to have multiple field tag numbers.

The approach to address this issue is as follows:

1. Use the field tag on panel schedules, drawings and the Configuration Item list.

The equipment asset sheet will act as the cross-reference between the SMART Number and the Field Tag number. The Equipment Asset sheet (embedded in SMaRT) has fields for the Field Tag number, NIF numbers (for parts association), and LOTO points.

- Buses and motor control centers
- CI Items
- Circuit breakers
- Emergency equipment
- Fire protection systems
- Fuse blocks or fuse locations
- Instruments and gauges
- Major equipment (e.g., tanks, pumps, and compressors)
- Switches
- Valves

APPENDIX F: PREVENTIVE MAINTENANCE ILLUSTRATED

SMaRT contains comprehensive tools for periodic preventive maintenance. A Preventive Maintenance Work Order is generated based on the Preventive Maintenance Schedule loaded in SMART. The PM Schedule is derived from the task list and performance schedule listed in the Subsystem's System Level Maintenance Plan.

An example to help illustrate the concepts is changing the oil in your car. We have used italics to clearly highlight the example text in the reminder of this document.

Example: You change the oil in your car every 3,000 miles. You change the filter in your furnace every year. This equipment operates better longer than if you did not perform these PM tasks.

The remainder of this section discusses three important aspects of establishing Preventive Maintenance for equipment or systems. The first is PM Schedule Setup, or the process to establish a Preventive Maintenance Schedule. The second is Performance windows or the methods and process for establishing if and when PM work Orders are generated. The third is the PM Durations for establishing the window for when the PM may be accomplished.

PM Setup

Setting up and using preventive maintenance is a multi-step process:

- Identify how often the PM should occur (i.e. periodicity)
- Establish a PM Schedule
- Plan the PM work using PM Schedule "Activities"
- Associate the objects you want serviced with the route, using "Routes"

The following paragraphs provide information and background on the process.

PM Schedule

A PM Schedule represents a set of established procedures (or Activities) to be executed, the frequency of their performance, the Equipment Objects on which the procedures will be performed, and a few other characteristics relative to the overall procedures.

Think of a PM Schedule as a template—to be duplicated every time a PM Work Order is executed.

A PM can be either "condition based" (example: mileage on a vehicle, xx% of light bulbs are burned out or when running current reaches xx milliamps, etc) or "frequency based" (example: elapsed number of days). These two PM types can also be used together so that whichever criterion is met first triggers the release of the associated PM Work Order. Based on this information the system lets you define PM generation windows.

Important Note: The reader should be aware that in order for a "condition based" PM to be effective, a meter must be set up and regularly updated in SMaRT to track the "condition". A suggested method to regularly update the meter is by taking periodic logs or readings and then transferring the data into SMaRT. As of this writing, SMaRT has few "condition based" PMs and the reader is advised to discuss this subject with the SMaRT Administrator before proceeding.

Example: Go back to the oil change example. If you have a fleet of vehicles, you would want to change the oil in the vehicles on a regular basis to ensure long engine life. The PM might be to change the oil and the frequency (or schedule) of oil changing would be every 3,000 miles. If you

have 60 vehicles, you may not want to change oil on all vehicles at the same time. You could set up 10 routes – each containing 6 vehicles – and apply those Routes to the 6 equipment Objects associated with the PM. That way you could maintain your 3,000 mile frequency while balancing the oil change workload over 6 separate schedules.

PM Work Order

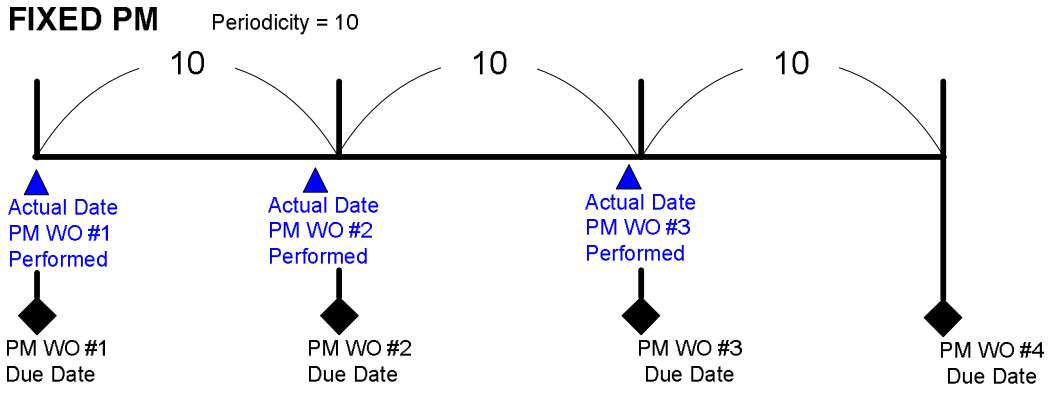
A PM Work Order then is an actual job issued against a PM for specific Equipment Objects that were associated to the PM.

In all aspects a Work Order produced from a PM Schedule, looks and is processed much in the same way as all other Work Orders in SMaRT. Once generated, PM Work Orders follow the same business process as defined in NIF's Maintenance Plan.

Types of PMs

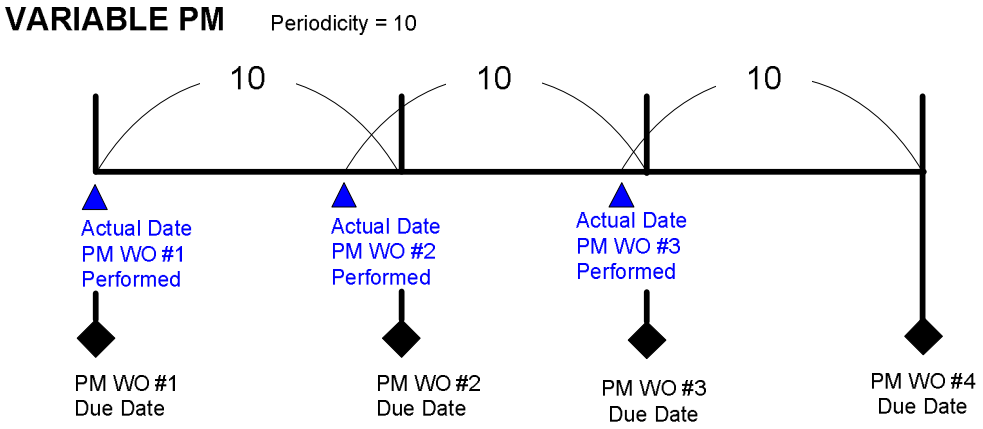
There are three types of PMs: Fixed, Variable, and Duplicate.

Fixed PMs have a set PM schedule. Whether a PM Work Order (say PM WO #1) is performed on-time, early, or late; the next scheduled date for performing the next PM Work Order (say PM WO #2) is determined by the Work Completed date (of PM WO #1) and the periodicity established for the PM. One example for the proper usage of a "Fixed PM" is a task that is dependent on the season. For instance, a task may be necessary to winterize a system each October regardless of when the PM may have been performed previously (e.g., annual freeze protection of outdoor water systems).



Variable PMs have a set periodicity but calculate the next PM based on date the PM was performed. If the PM Work Order (say PM WO #1) is performed on time, early, or late; the next scheduled time for performing the next PM (say PM WO #2) is due by adding the periodicity to the date the PM (PM WO #1) was performed.

For example if an annual (periodicity=365 days) PM Work Order was due 10/1/08 and it was actually performed 10/15/08, then the next PM Work Order will be due 10/15/09.



Duplicate PMs allow you to have more than one PM Work Order for the same Equipment Object at the same time. At the time this whitepaper is being written, Duplicate PMs are not being used in SMaRT until NIF becomes more versed in managing Work Orders.

Performance Windows

For PM Work Orders, consider a breakdown or unscheduled downtime as an opportunity to perform preventive maintenance since PM Work Orders usually call for shutting down equipment for the maintenance activities.

Example: Your vehicle has a brake failure requiring a rebuild of the wheel cylinder. Since the vehicle will be in the shop, you may want to change the oil at the same time – saving the extra effort and vehicle downtime of performing the oil change in the week when it is scheduled.

SMaRT allows you to establish OK, Near, and Release windows based on a percentage of the meter or frequency interval.

The following discussion assumes settings of

OK = 40%

Near = 70%

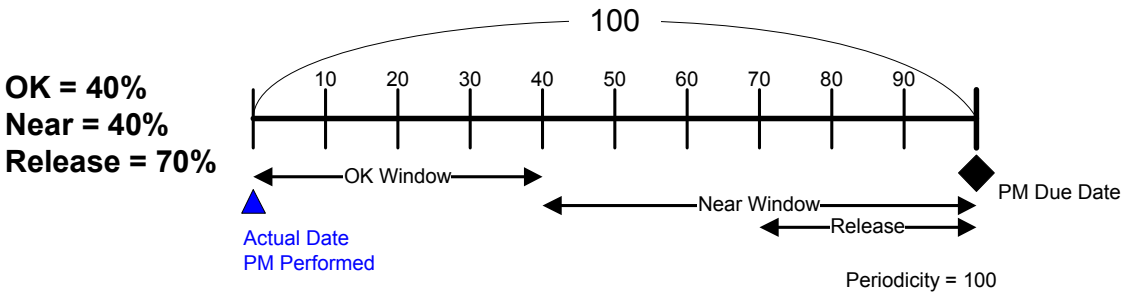
Release = 90%

When the frequency of the PM schedule is 100 days, the 40% OK indicated that for the 40 days (40% of 100) after completing a PM Work Order that PM does not need to be redone.

The Near Window (e.g. 40%) indicates that if a breakdown occurs in this window (e.g. 60 days) or less before the next occurrence of the next PM, it might be worthwhile to execute the PM together with the Reactive Maintenance.

When the Release value of 70% is reached (70 days have elapsed), you should perform the PM work order because its execution is pending soon.

The function of these windows is to help you decide whether to execute or not execute a PM action in the event that condition for an affected piece of equipment is favorable for doing the PM.



NIF uses the following default values for Work Order windows:

Window	Default Value when establishing PM Schedules in SMaRT	Amplifying Information
OK	0%	Only affects automatic generation of PMs. Since NIF manually generates PMs this value is not currently used in work production.
Near	0%	Only affects automatic generation of PMs. Since NIF manually generates PMs this value is not currently used in work production
Release	75% or 90% ** ** per following table	Currently used by NIF to determine when a Work Order is generated into Draft state.

Other values are available and the individual responsible for establishing the PM Schedule should review these default values and suggest other values as necessary.

Translating these default values into the available PM Periodicities produces the following table. The "Total Days the WO is generated" column equals the number of days prior to the PM Due Date which in SMaRT is currently the Approved Scheduled Start date. (Note: NIF is currently working to have the PM Due Date equal the Approved Scheduled End date)

PM	Periodicity	Release Window	Release before Approved Scheduled Start	Bias	Total days WO is Generated = Release Window + Bias
5 year	5 years	90%	185 days	3 weeks	206
3 year	3 years	90%	109	3 weeks	130
Biennial	2 years	75%	73	3 weeks	94
Annual	1 year	75%	91	3 weeks	112
Semi-annual	6 months	75%	45	3 weeks	66
Quarterly	3 months	75%	22	3 weeks	43
Monthly	1 month	75%	8	3 weeks	29
Weekly	7 days	75%	2	0	2
Bias = used to generate PMs earlier than the expected Release Window. This is generally used by P&S to provide a more advanced view of upcoming PMs. As confidence in SMaRT grows, this Bias should be replaced with customized Release Windows for each PM Schedule.					

PM Durations

The PM duration is the time allotted to perform the PM Work Order. Typically the unit of time is days. NIF currently uses the PM Duration as a 'window where the PM should be performed'. However, the intent is to ensure the PM window more accurately reflects the time it actually takes to perform the PM. In the future, we expect the PM Duration to be reduced for most PMs to just 1 or 2 days.

The PM duration window is modified during the life of the Work Order by the Subsystem Managers and Planning & scheduling groups as information is gathered regarding schedule availability and customer expectations.

PM Type	Default duration
5 year	45 days
3 year	45 days
Biennial	45 days
Annual	45 days
Semi-annual	30 days
Quarterly	14 days
Monthly	7 days
Weekly	1 days
Daily	1 day

The PM Due date is an internal date that is used by SMaRT and is generally not used in most reports. When a Work Order is generated, SMART sets the Scheduled End date to equal the PM Due date. SMaRT then sets the Scheduled Start date to be the Scheduled End date minus the PM Duration.

- Scheduled End Date = PM Due date
- Scheduled Start date = PM Due date - PM Duration

Illustration of a typical NIF PM

The following illustrations are based on typical PM Schedules being programmed into SMaRT today.

Example: We have a PM that we want to reoccur on an annual basis. The PM is then denoted as an Annual with a Periodicity of 1 year. From the tables above, the PM Duration is 45 days and the Release window is 91 days. Adding the 3 week bias to the Release window results in the Work Order being generated 112 days before the Approved Scheduled Start date.

Using actual dates to illustrate this example:

PM Due Date = 6/1/09

therefore, the Approved Scheduled start Date = 6/1/09

Adding 45 Days for the Duration,

the Approved Scheduled end Date = 7/16/09

Subtracting the Release Window and Bias from the PM Due Date results in the

PM generation date = 2/9/09.

If this PM is actually performed on 6/5/09, and the PM Type is **VARIABLE**, the next PM will be automatically setup as:

PM Due Date = 6/5/10

therefore, the Approved Scheduled start Date = 6/5/10

Adding 45 Days for the Duration,

the Approved Scheduled end Date = 7/20/10

Subtracting the Release Window and Bias from the PM Due Date results in the

PM generation date = 2/13/09.

OR if this PM is actually performed on 6/5/09, and the PM Type is **FIXED**, the next PM will be automatically setup as:

PM Due Date = 6/1/10

therefore, the Approved Scheduled start Date = 6/1/10

Adding 45 Days for the Duration,

the Approved Scheduled end Date = 7/16/10

Subtracting the Release Window and Bias from the PM Due Date results in the

PM generation date = 2/9/10.

APPENDIX G: SHIFT COVERAGE–CONVENTIONAL FACILITIES/ BEAMPATH UTILITIES TECHNICIANS

CF/ BUS O&M Groups support Shot Operations with a 7-day, 10-hour regular work schedule. This schedule is applicable to Field Supervisors and Technicians. Two teams of workers (Team A & B) are selected to provide sufficient staffing for complete coverage for the week. Each team is led by a Field Supervisor. The CF and BUS O&M Groups will focus on their specific work fronts and provide Field Supervisors from within their groups; however, the groups will work together for coordination of schedules and in the general performance of work. Weekly planning and technical coordination are performed on overlap days, i.e., Wednesdays.

The organization and details of the specific work shifts are shown below:

Team A

- CF Workgroup—general staffing
    - CF O&M group Field Supervisor—1
    - HVAC Technician—2
    - Electrical Technician—2
    - Mechanical technician—2
- BUS Workgroup—general staffing
    - BUS O&M group Field Supervisor—1
- Technician—3

Team B

- CF Workgroup—general staffing
    - CF O&M group Field Supervisor—1
    - HVAC Technician—2
    - Electrical Technician—2
    - Mechanical technician—2
- BUS Workgroup—general staffing
    - BUS O&M group Field Supervisor—1
    - Technician—3

Treatment of Holidays: Workers are expected to work on holidays that fall on the regular, scheduled workdays. All hours worked on a holiday are overtime. The Field Managers will determine the minimum staffing levels for holiday work.

APPENDIX H: FACILITY COLORS AND FINISHES

BUILDING COLOR ANALYSIS						
ID	**BLDG. AREA**	**MATERIAL**	**COLOR**	**STATUS**	**MANUFACTURER**	**CHANGE**
A^1	Conference Bldg.	CMU Block	None	Paint	Pratt & Lambert Paints	P&L #2254 "Zinc"
A^2	Conference Bldg. - bottom 6 courses	CMU Block	None	Paint	Dunn Edwards Paints	DE6231 "Shaker Gray"
B	Entry Jewel	Metal and Glass	Burgundy	As Is	None	None
C	Switch Yards	Stucco	Beige	As Is	None	None
D	Diagnostic	Metal	Light Green	As Is	None	None
D_1	Diagnostic Utilities	Metal	Beige/Metal	As Is	None	None
D_2	Diagnostic HVAC	Metal	Light Green	Paint	Dunn Edwards Paints	DE6300 "Windrock"
E	Utility Bldg at Argon	Metal	Light Green	Paint	Dunn Edwards Paints	DE6300 "Windrock"
F	Laser Bays	Metal	Light Green	As Is	None	None
G^1	Capacitor Bay North	Metal	Beige	Paint	Dunn Edwards Paints	DE6300 "Windrock"
G^2	Capacitor Bay South	Metal	Beige	Paint	Dunn Edwards Paints	DE6300 "Windrock"
G^3	Air Handlers @ Cap Bays	Metal	Beige	Paint	Dunn Edwards Paints	DE6300 "Windrock"
G^4	Air Ducts @ Air Handlers	Metal	Blue	Paint	Dunn Edwards Paints	DE6314 "Dark Pewter"
H	Low Building at OAB	Metal	Beige	As Is	None	None
I	B681 - OAB	Metal	Green	As Is	None	None
J	Block Building at OAB	CMU Block	None	Paint	Pratt & Lambert Paints	P&L #2254 "Zinc"
K	Block Building at OAB	CMU Block	None	Paint	Pratt & Lambert Paints	P&L #2254 "Zinc"
L	Central Plant	Metal Screen / Fencing	Green	Paint	Dunn Edwards Paints	DE6314 "Dark Pewter"
M	Utility Structures - Southwest Corner NIF	Metal and Fencing	Green	Paint	Dunn Edwards Paints	DE6300 "Windrock"
N	Main Ducts	Metal	Blue	Paint	Dunn Edwards Paints	DE6314 "Dark Pewter"
O	Misc. Utility Pipes	Alum Clad and Steel	Silver/Green	Paint	Dunn Edwards Paints	DE6314 "Dark Pewter"
P	Misc. Utility Boxes	Metal	Grey Green	Paint	Dunn Edwards Paints	DE6314 "Dark Pewter"
B583	Office Building	Stucco	Main Wall	Paint	Pratt & Lambert Paints	P&L #2254 "Zinc"
B583	Office Building		Trim Band	Paint	Dunn Edwards Paints	DE6231 "Shaker Gray"
B583	Office Building		"Eyelashes" / Entry Canopies	Paint		Cameron Red to match NIF entry
B581	Laser Bay - Walls		06-0091-LM	Sheen - 1650	Kelly Moore	
B581	Laser Bay - Doors		05-1850-LM	Sheen - 1685	Kelly Moore	
B581	Laser Bay - Pedestals (Red)		KM-599-M	Sheen - 1650	Kelly Moore	
B581	Laser Bay - Pedestals (Blue)		W-38-2	Sheen - 1650	Kelly Moore	
B581	Laser Bay - Pedestals (Gold)		06-893-LM	Sheen - 1650	Kelly Moore	
B581	Laser Bay - Pedestals (Green))		R-38-2	Sheen - 1650	Kelly Moore	
B581	Target Bay - Ceiling		White Rum	4208	Devflex QD	
B581	Target Bay - Walls		P-88 String	4208	Devflex QD	
B581	Target Bay - Corridor Walls		Frost	1650	Kelly Moore	
B581	Target Bay - Corridor Doors		Windrock	1650	Kelly Moore	

APPENDIX I: GUIDELINES FOR WRITING SYSTEM LEVEL MAINTENACE PLANS AND MAINTENANCE PROCEDURES

This guideline generates a more complete System Level Maintenance Plan or Maintenance Procedure that works to incorporate aspects associated with Configured Items or Configured Systems. These guidelines do not supersede NIF Management Procedures.

This document provides guidance for the following actions:

- Updating System Level Maintenance Plans (SLMPs)
- Updating existing Maintenance Procedures
- Generating new maintenance procedures—before Validation
- Revising maintenance procedures—after Validation

Updating System Level Maintenance Plans (SLMPs)		
1	Sub-System Manager	Remove all procedures from the SLMPs.
2	Sub-System Manager	Check if the sub-system contains CI's. This will be documented in the Configured Items lists (refer to NIF-5018525 for a list of Configured Systems and the associated lists.)
3	Sub-System Manager	If there are components on the CI list that are included in the hierarchy of the sub-system, then check if the components on the CI list includes any items listed as requiring Independent Verification (IV). If so then proceed to Step 5. Otherwise, proceed to Step 6.
4	Sub-System Manager	If so, then add an annual Independent Verification (IV) maintenance task to Table 10-1. Also, write a procedure which lists all components requiring IV, their required position, and a blank to fill in their verified "actual" position. Example follows:

Component	**Required Operating Position**	**Actual Position**	**Technician's Initials**
Field Tag number	*Procedure writer should state the position the component should be in for operations*	*Procedure writer should leave this blank. The technician will fill this in the field*	*Procedure writer should leave this blank. The technician will fill this in the field.*

5	Sub-System Manager	Check the CI list for all sub-system components listed as "requiring calibration". If the CI list states

		that the components require calibration, then proceed to Step 7. Otherwise proceed to Step 8.
6	Sub-System Manager	Ensure a procedure exists for Calibration of the component. If none exists then, include the procedure and a calibration frequency in the SLMP Section 13.2.
7	Sub-System Manager	Document the file location (network subdirectory or ECMS) of the procedure shown on each line in Table 13-1.
8	Sub-System Manager	Include the ECMS number of each maintenance procedure in Table 13-1 of the SLMP as shown in the example table below:

Title	**Procedure file location or ECMS number**	**Frequency**
Title of Procedure	*Procedure writer should list the subdirectory and file name or ECMS number (preferred)*	*Procedure writer should list the frequency (e.g. weekly, monthly, annual, 3 years, etc)*

9	Sub-System Manager	Remove the word "draft" from anywhere in the SLMP filename or title.
10	Sub-System Manager	Search the SLMP for 'TBDs' and either work to fill in information or provide a better descriptor for why the information is not available at this time.
11	Sub-System Manager	Working with the Configuration Management Group, a. Write an ECR documenting the changes. b. Route the SLMP in ECMS for approval.
13	Planning & Scheduling	Attach the Maintenance Plans to the PM Schedule. Attach the SLMP to the SMaRT document library

Table 1			
SLMP name	Procedure name	ECMS Number	SMaRT file Number

Updating Existing Maintenance Procedures		
1	Sub-System Manager	Obtain the most current maintenance procedure.
2	Sub-System Manager	Update the maintenance procedure to the current

Updating Existing Maintenance Procedures		
		template.
2a	Sub-System Manager	Add FMEA section.
2b	Sub-System Manager	Ensure there is a section for Independent Verification (IV) and Post-Maintenance Testing (PMT) for those assets as identified on the CI list as needing IV or PMT. The IV step shall list the individual components, their required position, and contain a blank to fill in their verified "actual" position.
2c	Sub-System Manager	Include a paragraph that states: ATTENTION – ATTENTION – ATTENTION This procedure has not been Verified or Validated in the Field. Perform this procedure ONLY in the presence of the Subsystem Manager or designee. Make notations and deliver the completed procedure to the Subsystem Manager as part of the Work Closeout Process" *Note: If the sub-system manager delegates the task of observing the first performance of the procedure (i.e. designee), the name of the designee must be documented on the work permit.*
3	Sub-System Manager	Check the CI list for the Independent Verification Requirement for all components impacted by the Maintenance Procedure. If the CI list states that the components require IV, then proceed to Step 4. Otherwise proceed to Step 5.
4	Sub-System Manager	Include Independent Verification within the Maintenance Procedure by stating in the procedure at the point at which IV should occur: "By performing this maintenance activity, Independent Verification of the as-left position of devices and components is mandatory. Unless specifically detailed herein, the individual performing Independent Verification by signing below states that the devices are in the proper position for operation" At the proper point in the maintenance procedure, add a step listing all components that require IV per the CI List, their required position, and a blank to fill

Updating Existing Maintenance Procedures		
		in their verified "actual" position as shown in the following table:

Component	Required Operating Position	Actual Position	Technician's Initials
Field Tag number	*Procedure writer should state the position the component should be in for operations*	*Procedure writer should leave this blank. The technician will fill this in the field*	*Procedure writer should leave this blank. The technician will fill this in the field.*

5	Sub-System Manager	If the procedure is already loaded in ECMS, then write an ECR and increment the procedure's version number. Working with the Configuration Management Group, load procedure into ECMS for approval routing.

Generating New Maintenance Procedures—before Field V&V		
1	Sub-System Manager	Within NIF Procedure 11.1, *The NIF Management Procedures: Index and Writer's Guide*[7] use the Maintenance Procedure template to create the Maintenance Procedure. Denote the Maintenance Procedure as "Revision 0" in the title block.
2	Sub-System Manager	Insert a warning label block on the first page underneath the title block that states: ATTENTION – ATTENTION – ATTENTION This procedure has not been Verified or Validated in the Field. Perform this procedure ONLY in the presence of the Subsystem Manager or WPRI. Make notations and deliver the completed procedure to the Subsystem Manager as part of the Work Closeout Process"
• Revision 0 is Subsystem Manager's best effort at creating stand-alone procedure that is sufficiently well developed to allow maintenance to be performed without the Subsystem Manager's oversight. • Revision 0 is a draft procedure that will still need Validation and Verification to ensure that it is complete and appropriate and can be performed as written. In general, if *any* intervention or explanation by the		

Generating New Maintenance Procedures—before Field V&V		
	Sub-system Manager is required for the technician to complete the maintenance, the procedure requires improvement before upgrading to "Revision 1."	
3	Sub-System Manager	Working with the Configuration Management Group, load the procedure into ECMS for approval routing.
	• Revision 0 will be released in ECMS prior to work so as to allow SMaRT to directly link to the procedure located in ECMS. This avoids the manual manipulation that would be necessary to manage procedures located on a network server. • Since this is a new procedure, the version is AA in ECMS	

Revising Maintenance Procedures—after performing Validation		
	Validation is performed using a Revision 0 procedure by performing maintenance under the direct observation of the Subsystem Manager. During the Validation, the technician and Sub-System Manager will red-line the Maintenance Procedure as work is performed per Procedure 6.4.[23] "In general, if any intervention or explanation by the SSM is required for the technician to complete the maintenance during the Validation, the procedure requires improvement before upgrading to Revision 1."	
1	Sub-System Manager	Incorporate the red-lines into the procedure. The resultant procedure is considered Revision 1 which indicates that Validation has been performed.
2	Sub-System Manager and Field Manager	Determine whether the procedure (incorporating the necessary corrections and revision from the Validation) is now able to be performed without the express oversight of the Subsystem Manager or WPRI. If YES, go to Step 3. If NO, go to Step 4.
3	Sub-System Manager	Delete the warning label block on the first page underneath the title block that states: ATTENTION – ATTENTION – ATTENTION This procedure has not been Verified or Validated in the Field. Perform this procedure ONLY in the presence of the Subsystem Manager or WPRI. Make notations and deliver the completed procedure to the Subsystem Manager as part of the Work Closeout Process.

Revising Maintenance Procedures—after performing Validation		
		Change the maintenance procedure to "Revision 1". Go to Step 5.
4	Sub-System Manager	Add or retain the warning label block on the first page underneath the title block that states: ATTENTION – ATTENTION – ATTENTION This procedure has not been Verified or Validated in the Field. Perform this procedure ONLY in the presence of the Subsystem Manager or WPRI. Make notations and deliver the completed procedure to the Subsystem Manager as part of the Work Closeout Process. The maintenance procedure will remain "Revision 0". Go to Step 6.
5	Sub-System Manager	If the procedure is already loaded in ECMS, then write an ECR and increment the procedure's version number. On the ECR state that the Maintenance Procedure has been Field Verified and that the procedure will be incremented to Revision 1.
6	Sub-System Manager	Working with the Configuration Management Group, load procedure into ECMS for approval routing. The Approval Routing is per NIF Project Procedure 5.14 and should include as a minimum the Subsystem Manager, Field Manager and COM. Include the Configured System Manager in the Approval Routing if the Maintenance Procedure affects a CI that is not a CSS. Include the Safety Analyst in the Approval Routing if the Maintenance Procedure affects a CI that is a CSS.

APPENDIX J: WORK ORDER PRIORITY MATRIX

To use the table, select the Probability of Failure and the Equipment Class using the definitions below. The Priority results from the intersection of these inputs.

		Probability of Failure			
		Imminent	Impending	Intermediate	Indefinite
Equip / System Class	ESS	Priority 1	Priority 2	Priority 3	Priority 4
	MC	Priority 2	Priority 3	Priority 4	Priority 5
	MP	Priority 3	Priority 3	Priority 4	Priority 5
	BP	Priority 4	Priority 5	Priority 5	Priority 5

Equipment/System Class

Environmental, Safety and Security (ESS):	Safety equipment required for compliance with authorization basis or required for compliance with industry/LLNL codes and standards. Equipment or system failure that will have a negative impact on the environment or security requirements. This includes any work on configured items that reside in safety credited systems.
Mission Critical (MC):	Equipment failure is unacceptable for accomplishment a major mission milestone, personnel safety, or risk to capital assets.
Repetitive Maintenance (RM): Maintenance Plan (MP)	Equipment/System that requires preventive, predictive or reactive (not ESS or MC) maintenance
Balance of Plant (BP):	Equipment not required for ESS or classified as Mission Critical or is not defined in the Maintenance Plan as a maintainable asset.

Probability of Failure

Imminent:	System /component failure imminent (0 to 2 months). Requires immediate work.
Impending:	System /component failure impending (within 2 to 12 months). Near-term action required.
Intermediate:	System /component failure likely within one to three years. Degradation of reliability should be expected.
Indefinite:	Expected greater than 3 years.

Note 1: Environmental, Safety or Security failures may be mitigated and assigned a lower Probability of Failure level based on the allowable period for corrective action.

APPENDIX K: KEY PERFORMANCE INDICATORS (KPI) AND REPORTS

Worker Utilization

Utilization is reported monthly. It is comprised of the actual effort hours booked to closed-out work orders against the potential work hours (see Figure 10). This allows the Field Managers to track the percent of their work that is being performed, using a SMaRT Work Order in order to meet a goal; 80% utilization of available technician work hours are tracked using the SMaRT system. The formula used is:

Worker Utilization = Actual Effort (hrs)/Potential (hrs) * 100

Potential—all technicians, reported work hours

Actual—summation of technician work hours reported from SMaRT for Closed-Out Work Orders

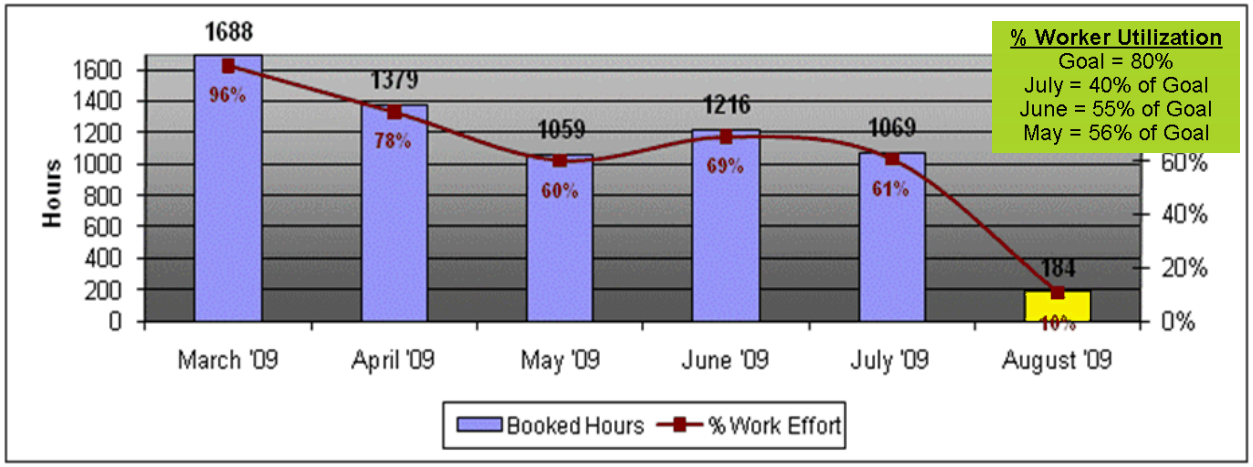


Figure 10. Worker Utilization Metric Example

As SMaRT is expanded for Work Order scheduling, the resolution of this metric will show employee work distribution and utilization on a weekly basis.

CF/BUS Plan of the Day (POD)

For regularly scheduled workdays, the Field Managers distribute a Plan of the Day (POD), which lists the intended work for that day and associates workers to each job (see Figure 11 as an example). With this document, the Field Managers communicate the work distribution to their staff and additionally report it to NIF management or other affected organizations. For more information, refer to the Work Coordination Procedure within the Internal Operations Process (NIF-0113509).[14]

JOB FRONT	Permit	WO	Location	Arias	Barberis	Cameron	Dagle (new)	Harvey	Jiminez	Kalepp
Active Work										
Landscape Maintenance	234921	n/a	Sitwide					X	X	
~~HW Leak repair (B. Buhowsky working now)~~	~~236291~~	~~69812~~	~~West B583~~			~~X~~				
SY2 Temp issue troubleshoot	233812	tbd	SY2	X		X				
Repair unsealed wall penetrations	234971	69407	Rm 1017 1016					X	X	X
door repair (D006)	234970	69600	SY2 B3					X	X	X

Figure 11. POD Example (CF O&M Group)

Work Order Type and Class

The work order type and class metric (i.e., PM, RM, Safety) is reported on a monthly basis. It shows, as a count of Work Orders, the "Type" of Work that is being performed in the field (see Figure 12). There are four Work Order Types: Repair/Reactive Maintenance, Preventive Maintenance, Active Projects, and Other. A goal is for the Preventive Maintenance/Reactive Maintenance ratio to be $\geq$ 4:1.

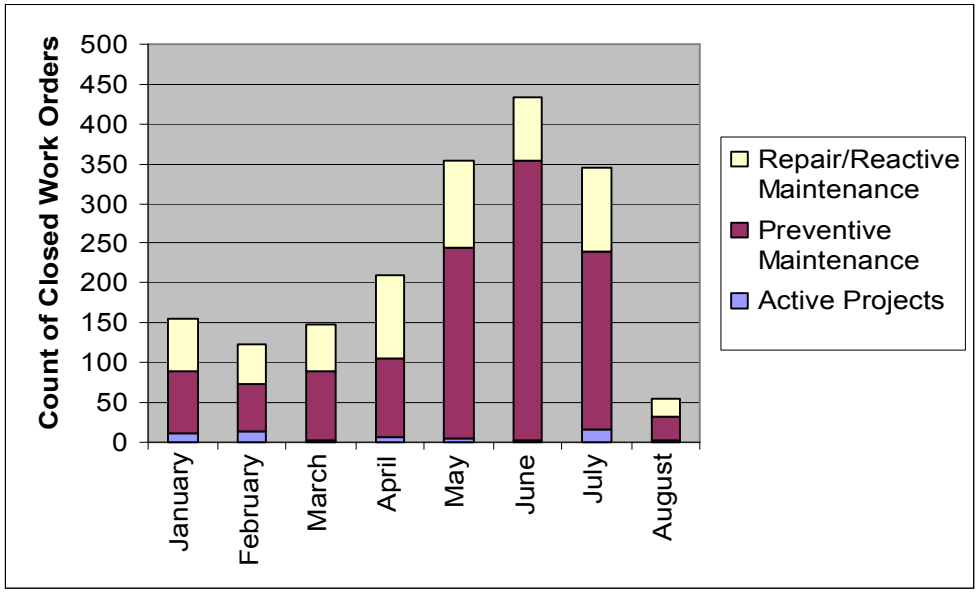


Figure 12. Type of Work

In some cases, the Work Order Type does not have sufficient resolution for reporting purposes. In these cases, the Work Order Class, a second level of detail under Work Order Type, may also be reported (see Table 13). This metric, although available, is not regularly reported.

Table 13. Work Order Class

Class	Description	Organization
*	All Other Work Orders	*
*	All Other NIF Work Orders	NIF
ADMIN	Administrative	*
CAL	M&TE Calibration	*
COMM	Commissioning	*
CONST	Construction	*
DES-CONS	Design Construction Work	NIF
DESIGN	Design Work	NIF
MAINT	Predictive/Maintenance	NIF
OPS	Ops Support/Control Rm/Logs	*
PLAN	FCOM Planning	*
PM	Preventive Maint.	*
REAC	Non-PM Maint./Repairs	*
SIR	Safety Issue Resolution	NIF
WFO	Work For Others	*

Work Order Volume

"Volume" is the measurement of the number of work requests coming into the maintenance organization and the number of work orders being closed out. This is a performance measurement that indicates how often our processes are being used and how effectively (see Figure 13). The individual metrics are discussed below in detail.

1. Request Line Volume

- Purpose: Staffing adjustment
- Description: Indicates the number of Work Orders processed through the Request Line
- Goal: None (establishing baseline)
- Measurement time period: Monthly

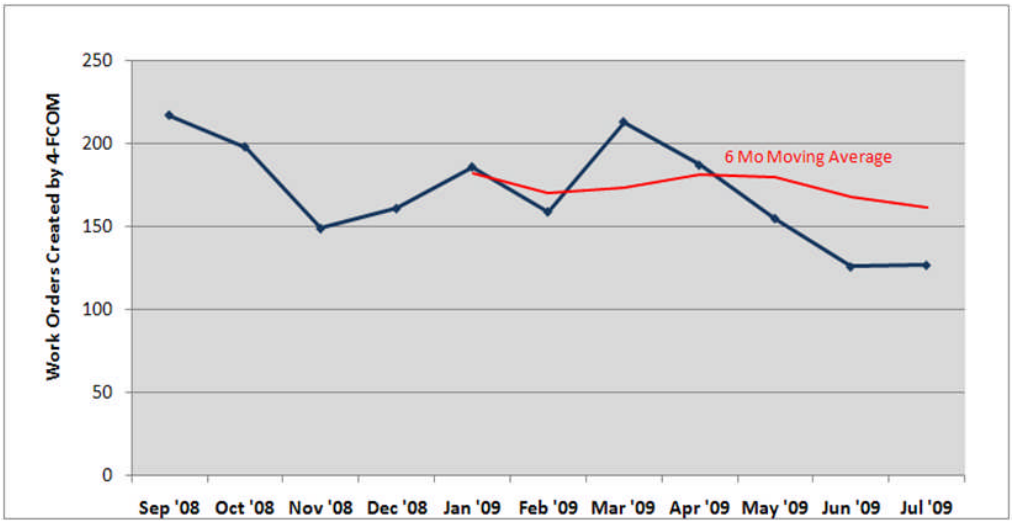


Figure 13. Request Line Volume

2. Work Order Close-Out Volume

- Purpose: Staffing adjustment
- Description: Indicates the number of Work Orders being closed-out in a given week (see Figure 14).
- Goal: None (establishing baseline)
- Measurement time period: weekly

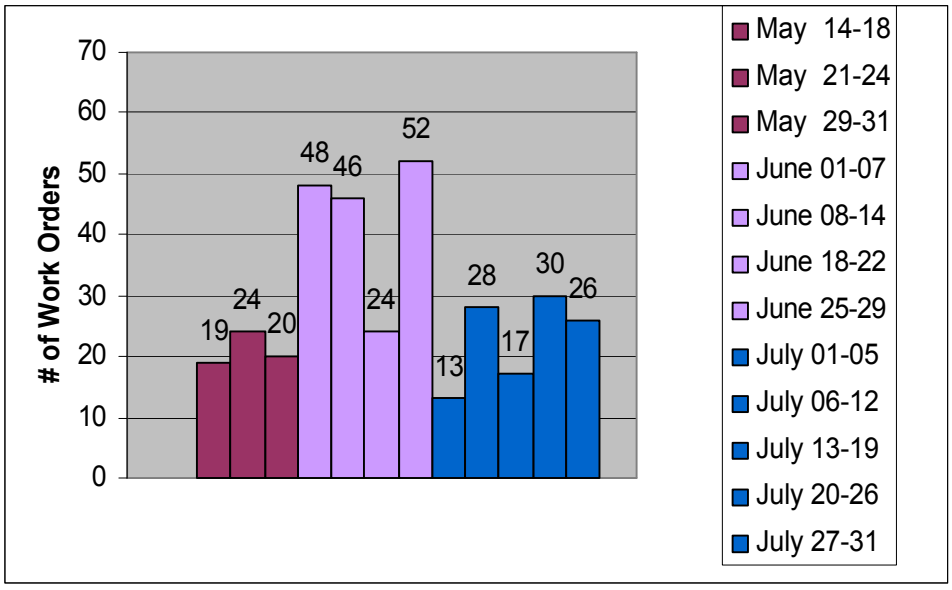


Figure 14. Work Order Close-Out Volume

3. Work Order Open/Close Volume

- Purpose: Analyze if more work is coming into the organization than the organization can support. An increased offset, between the open and closed data sets, will result in an increase in backlog.

- Description: Indication of total work coming into the maintenance organization (all new Work Orders created in a given month) and being closed-out (see Figure 15).
- Goal: None (establishing baseline)
- Measurement time period: Monthly

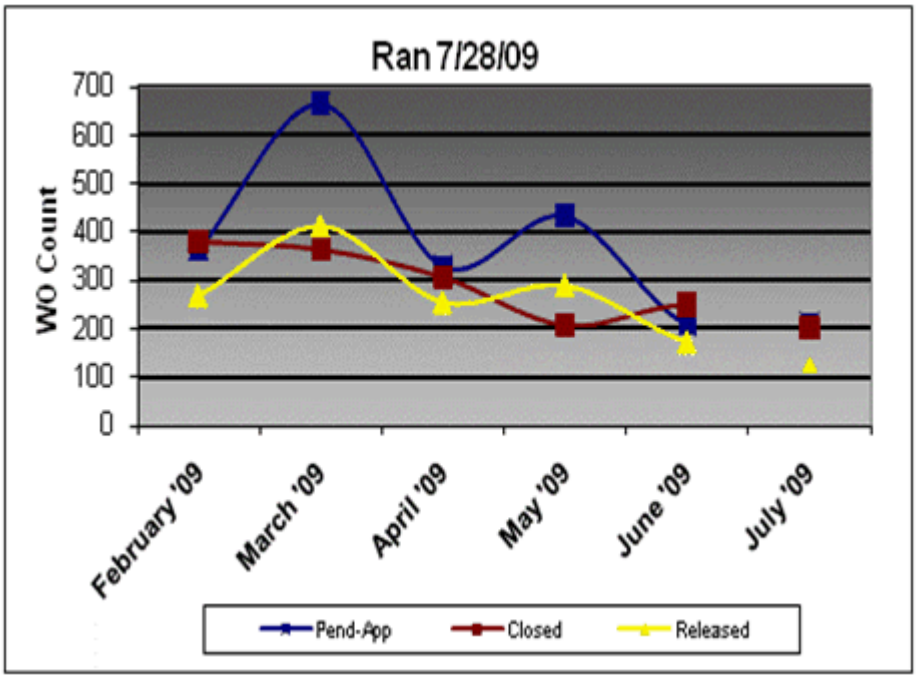


Figure 15. Work Order Open/Close Volume

ENGINEERING WORK ORDER BACKLOG

- Purpose: Work allocation decisions
- Description: Engineering Backlog is defined as all Work Orders that are in pending state and are awaiting review by the Subsystem Manager (see Figure 16).
- Goal: None (establishing baseline)
- Measurement time period: Weekly

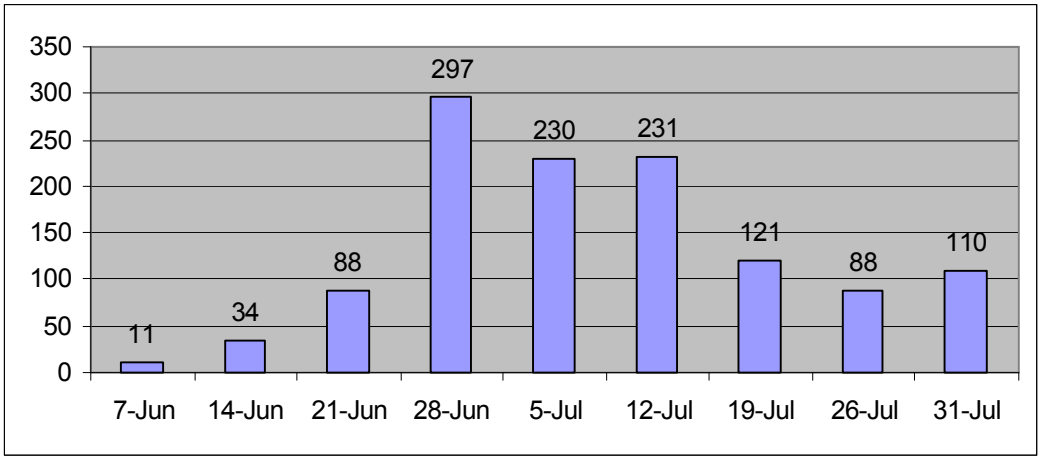


Figure 16. Engineering Work Order Backlog

OPERATIONAL WORK ORDER BACKLOG

Backlog is defined as all Work Orders that have been approved by the Subsystem Manager but have not been closed out. The total backlog count does not include SMaRT Work Orders that are on hold or listed at Priority 5.

There are a number of various metrics that are run to uncover data trends for Work Order Backlog. These are discussed in detail below.

1. Backlog by Priority

- Purpose: Data is used in a table form for review in the weekly CF/BUS RM/PM scheduling meetings.

- Description: Indicates that the Work Order priority system is effective and that the distribution of Work Orders is reasonable.

- Goal:
  - Total Work Order Backlog < 300 Work Orders
  - Downward slope from priority 5 to priority 1 (see Figure 17)

- Measurement time period: weekly

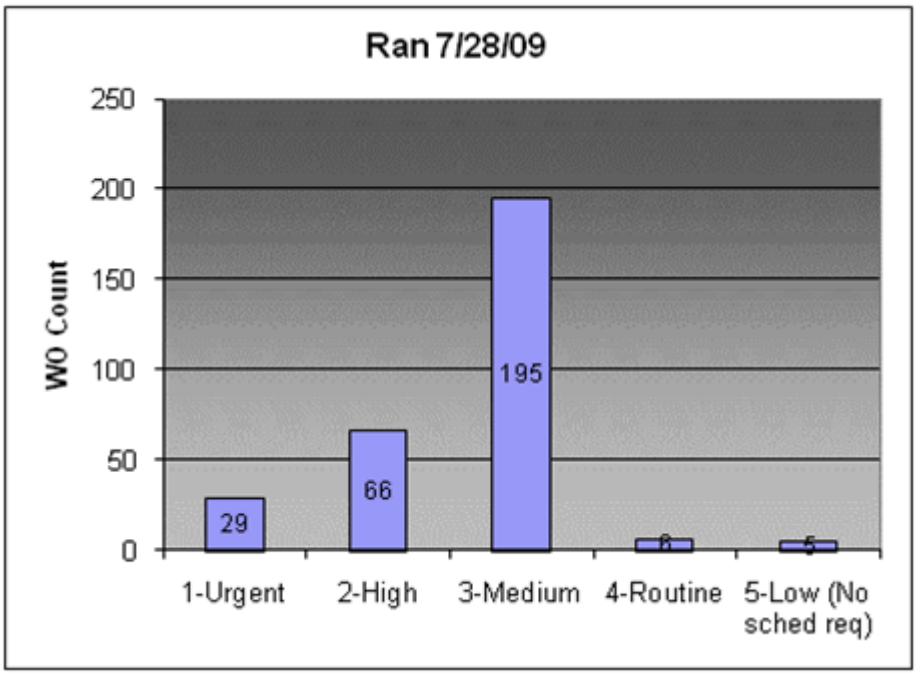


Figure 17. Weekly Backlog

2. Backlog Trend

- Purpose: Inform Management of the Work Orders that will soon become part of their backlog.

- Description: Indicates the backlog trend over time (see Figure 18). Weekly *Backlog by Priority* data is used to create this trend. In addition, the newly created Work Orders weekly count is also shown on this metric.

- Goal: None (establishing baseline)

- Measurement time period: Weekly

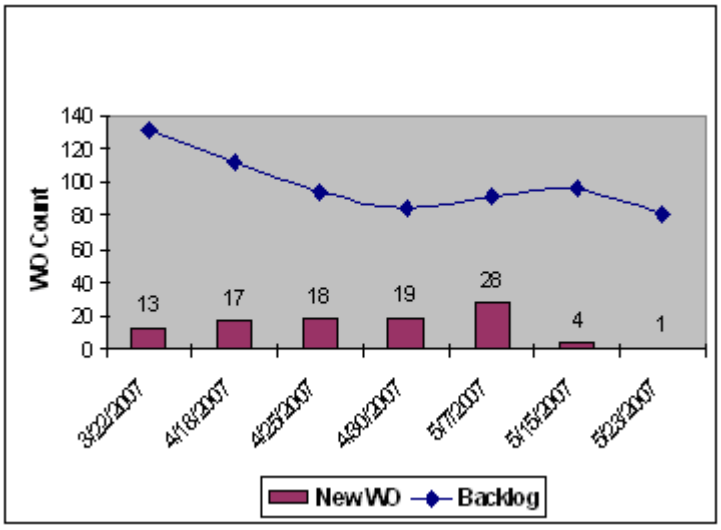


Figure 18. Weekly Trend

Work Order Aging

Work Order aging is derived from the amount of time the Work Order life cycle took to complete. This amount of time is referred to as the Work Order duration and is calculated as seen below. This data is only derived for Work Orders that are in the closed-out state and does not include Work Orders that have been canceled.

Work Completed Date – Reported Date = Work Order Duration

This duration is used to categorize the Work Orders into one of seven age spans (e.g., < 5 days, >125 days, etc.) for the purposes of data analysis. This data is used in a number of various metrics discussed below.

Work Order Aging Distribution

- Purpose: This data is used to explain the age distribution of work orders when questions are raised from the *Average Work Order Age by Priority* Metric.
- Description: Indicates the age range of the Work Orders that have been closed in a given month (see Figure 19).
- Goal: None (establishing baseline)
- Measurement time period: Monthly

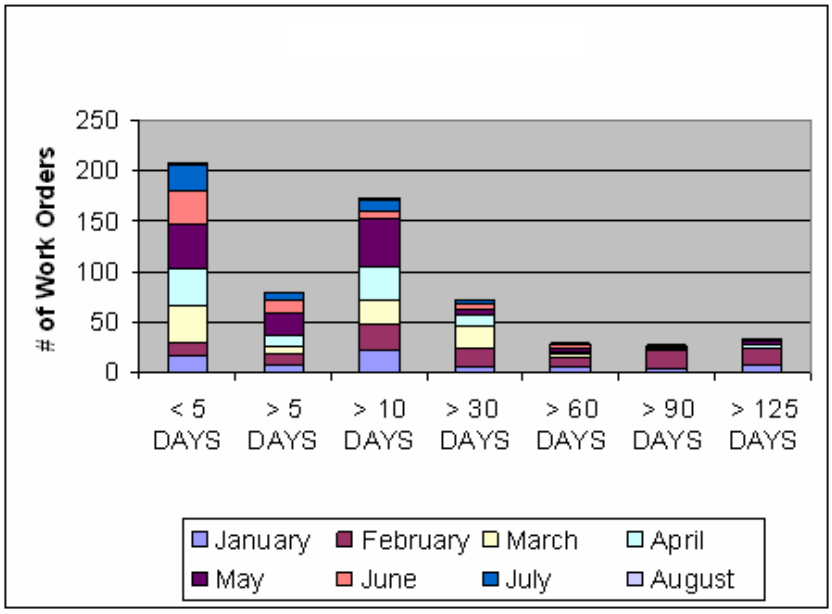


Figure 19. Work Order Aging Distribution

Average Work Order Age by Priority

- Purpose: to ensure that the Work Order age is in line with the below goals (see Figure 20).
- Description: Indicates the average age of the Work Orders by priority level.

- Goal:
  - 30 working days for Priority 1 and 2 Work Orders
  - 60 working days for Priority 3 Work Orders

- Measurement time period: Monthly

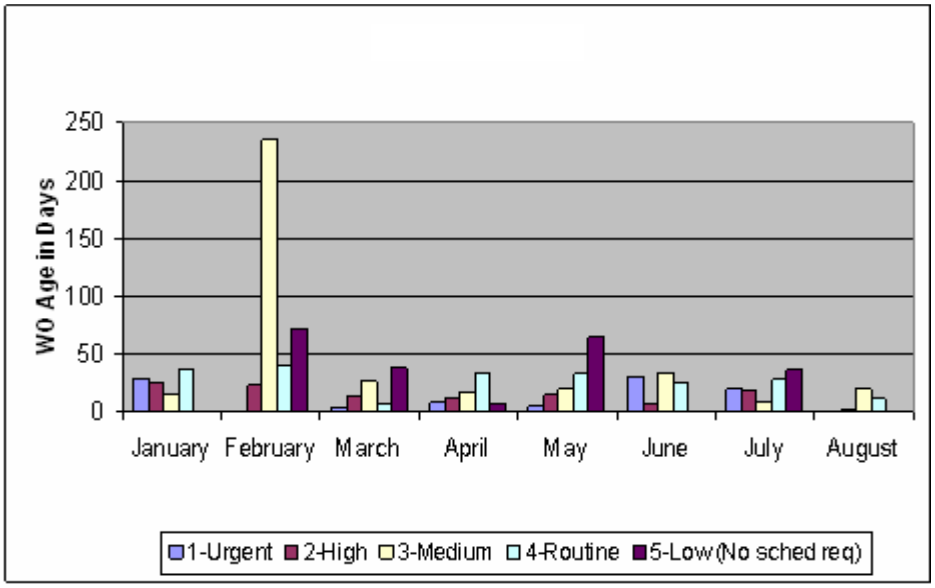


Figure 20. Average Work Order Age by Priority

Budget vs. Actual Cost (future)

The Budget vs. Actual metric has not been defined at this time. This section is for assurance of its inclusion in an upcoming revision to this document.

Technical Training/Qualifications (future)

Once the Maintenance Training documents have been completed (e.g., Qualification Cards) this metric will be developed.

APPENDIX L: TECHNICAL/SYSTEM METRICS

Technical/System Metrics

1. System Availability, Y axis = % uptime, X axis = months

The data for this metric is beginning to be tracked under the RAM metric. However, this section will be defined in an upcoming revision to this document.

2. % PM Performed/System vs. Planned

Once the O&M Implementation has been completed these metrics will be developed.

3. Reliability, Availability, and Maintainability (RAM)

- Purpose: To provide the RAM of all CF/BUS systems.
- Description This data allows trends the CF/BUS systems' health and provides information to calculate the projected NIF Availability.
- Goal:
  - 0 RAM Failures as reported in monthly RAM Metrics
  - System, repair and operational downtime is tracked
  - 100% Availability of all Systems excluding scheduled maintenance activities and uncommissioned systems
- Measurement time period: Monthly Report

APPENDIX M: ROLES AND RESPONSIBLITIES

Planner

Position Scope and Purpose:

Part of the NIF Facility Operation and Maintenance (FOM) Planning and Scheduling team who, under general direction, plans the day to day work activities of the NIF FCOM O&M groups. The Junior Planner's primary responsibility is to process and administer work orders, for all work types ranging from customer requests to maintenance tasks. In addition, the Junior Planner plays an active role in supporting moderate to advance local administration issues involving the Computerized Maintenance Management System (CMMS) including user support, training, and Business Rule monitoring. All members of the Planning and Scheduling Team are responsible for providing superior customer satisfaction through continual communication and follow-up.

Detailed Responsibilities:

- Provides technical and administrative support including planning and coordinating manpower, material and defining work interactions.
- Ensure equipment preventative maintenance work execution by receiving, planning, estimating, and coordinating maintenance work orders.
- Provide workload scheduling, notification and maintenance tracking services for FCOM.
- Ensure the timely and coordinated availability of parts, materials, special tools and equipment, labor hours and skills required for orderly and efficient work execution.
- Actively participates in developing, implementing and maintaining work, planning and scheduling processes.
- Supports the definition and development of Business Processes.
- Implement, monitor and adjust Business Processes for Work Management to ensure efficient Work Production conditions.
- Conduct comprehensive assessments for key operational processes and identify key improvement opportunities.
- Perform data extraction, reporting and analysis to troubleshoot process problems and make recommendations regarding the support of custom/specialized reporting capabilities.
- Develop and integrate with Operations long and mid-term plans required for maintenance outages.
- Research, understand, develop, and implement CMMS user documentation, training, and manuals.
- Identify CMMS user needs, develop and generate reports from within SMaRT including metric data
- Act and perform as a Local System Administrator for the CMMS.
- Provide a combination of advanced specialized technical and database administration support in planning and coordinating parts, materials, special tools and equipment, labor hours and skill set required for orderly and efficient work execution.

- Rotate the role of 4-FCOM "Request Line Agent" with other team members and provide Administrative and Technical customer service support (i.e., inform various requestors of the status of work milestones).
- Comply with ES&H and Security requirements and policies by ensuring that work is performed safely and provide for a safe working environment; corrects or reports to supervisor any hazard/risk or potential hazard.

Scheduler

Position Scope and Purpose:

Part of the NIF Facility Operation and Maintenance (FOM) Planning and Scheduling team who, under general direction, plans the day to day work activities of the NIF FCOM O&M groups. The Senior Planner's primary responsibility is to process and administer work orders, for all work types ranging from customer requests to maintenance tasks. In addition, the Senior Planner plays an active role in supporting moderate to advance local administration issues involving the Computerized Maintenance Management System (CMMS) including user support, training, and Business Rule monitoring. The Senior Planner is also responsible for providing superior customer satisfaction through continual communication and follow-up.

Detailed Responsibilities:

- Assists in the entire Work Order life cycle from entry to closure. Is the overseer of this process and understands how work is truly performed in the field. Receives work requests and verifies completeness of information entered into the CMMS. Communicates work order tracking numbers to customer and assigns the work order to the appropriate O&M Manager.
- Communicates with the customer to understand the technical scope of work to be performed, priority of the work and possible affect on other work areas. Ensures that the requestor is updated until the Work Order has been completed.
- Supports the definition, development, implementation, monitoring, and adjustment of Business Processes for Work Management to ensure efficient Work Production conditions.
- Understands the methods and tools in place for the measurement and monitoring of manpower, materials, equipment, and time. Ensure that these methods and tools provide accurate data.
- Tracks Work Orders, through their life cycle, paying particular attention to Work Order status and equipment history such as repair costs.
- Analyzes Work Order data to understand effectiveness of O&M Processes and overall Work Production Performance. Will also provides recommendations based on data for improvements including the use of outside services, possible cost reductions, and utilization.
- Coordinates and plans outages and shutdowns with all affected parties.